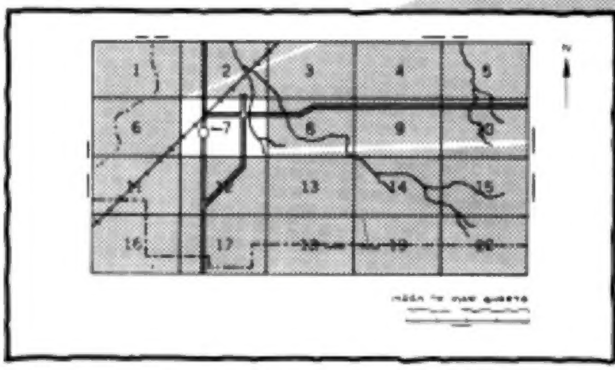
SOIL SURVEY OF

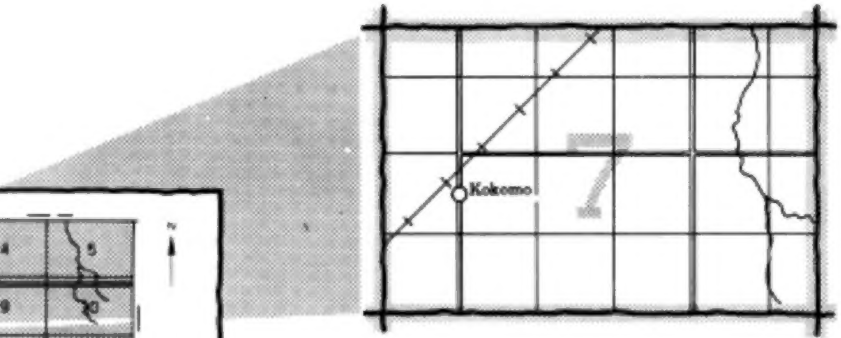
Kiowa County, Colorado

United States Department of Agriculture,
Soil Conservation Service,
in cooperation with
Colorado Agricultural Experiment Station

HOW TO USE

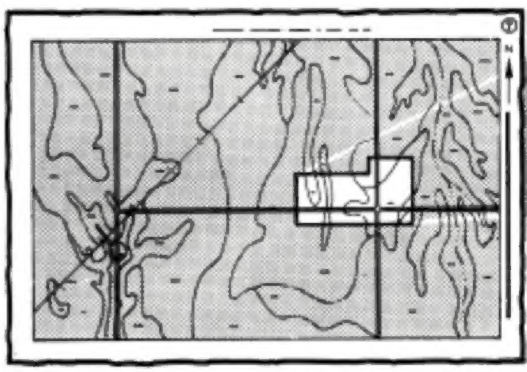
1. Locate your area of interest on the "Index to Map Sheets"

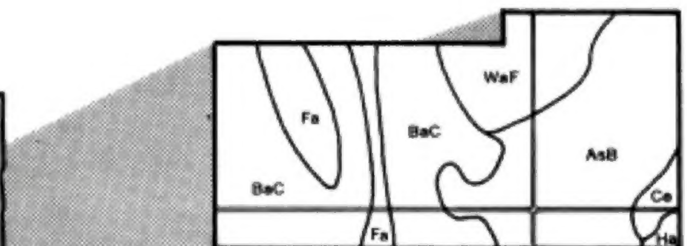




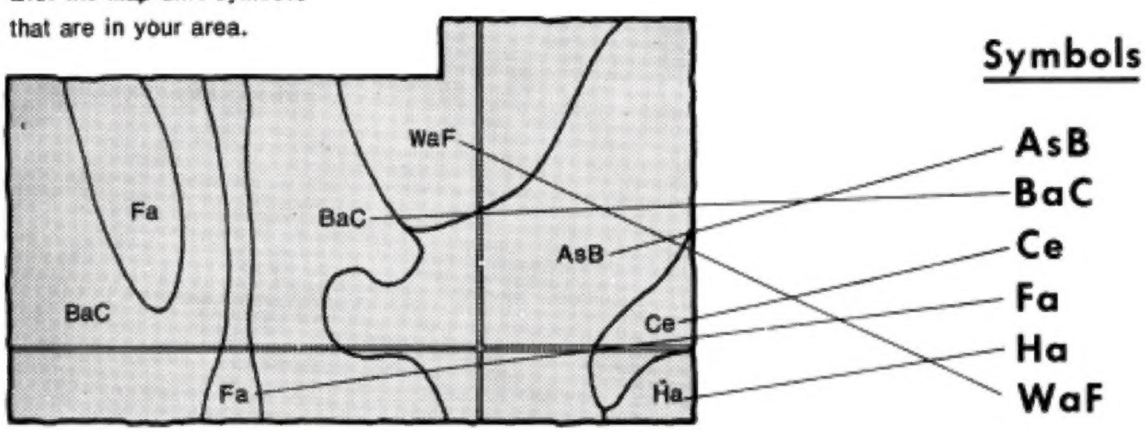
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



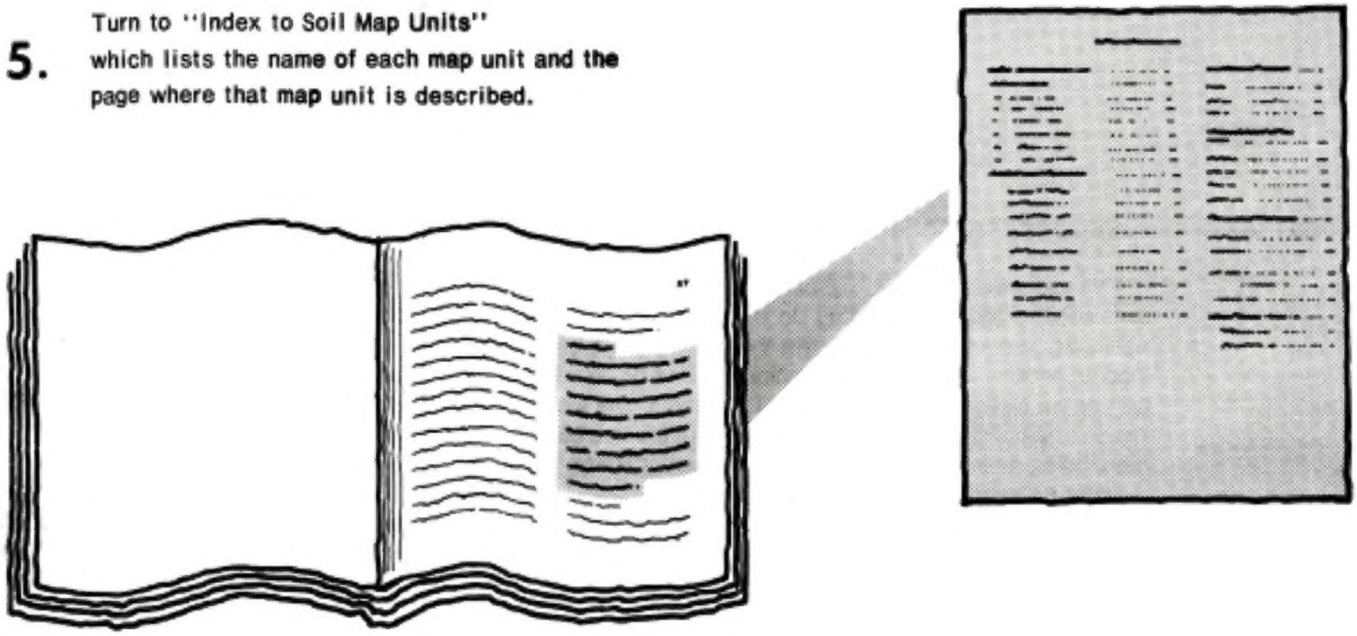


4. List the map unit symbols that are in your area.

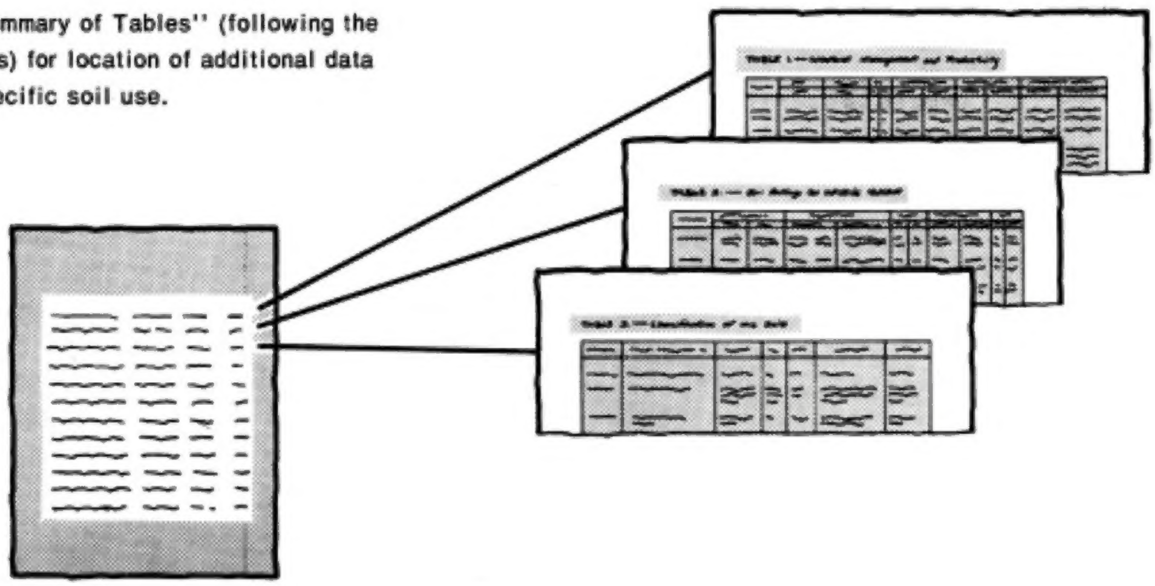


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1976–77. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1977. This survey was made cooperatively by the Soil Conservation Service and the Colorado Agricultural Experiment Station and the Kiowa County Soil Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps can cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

Cover: Wheat harvest on Bijou-Valent loamy sands, 1 to 8 percent slopes.

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Issued August 1981

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Foreword

The Soil Survey of Kiowa County contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

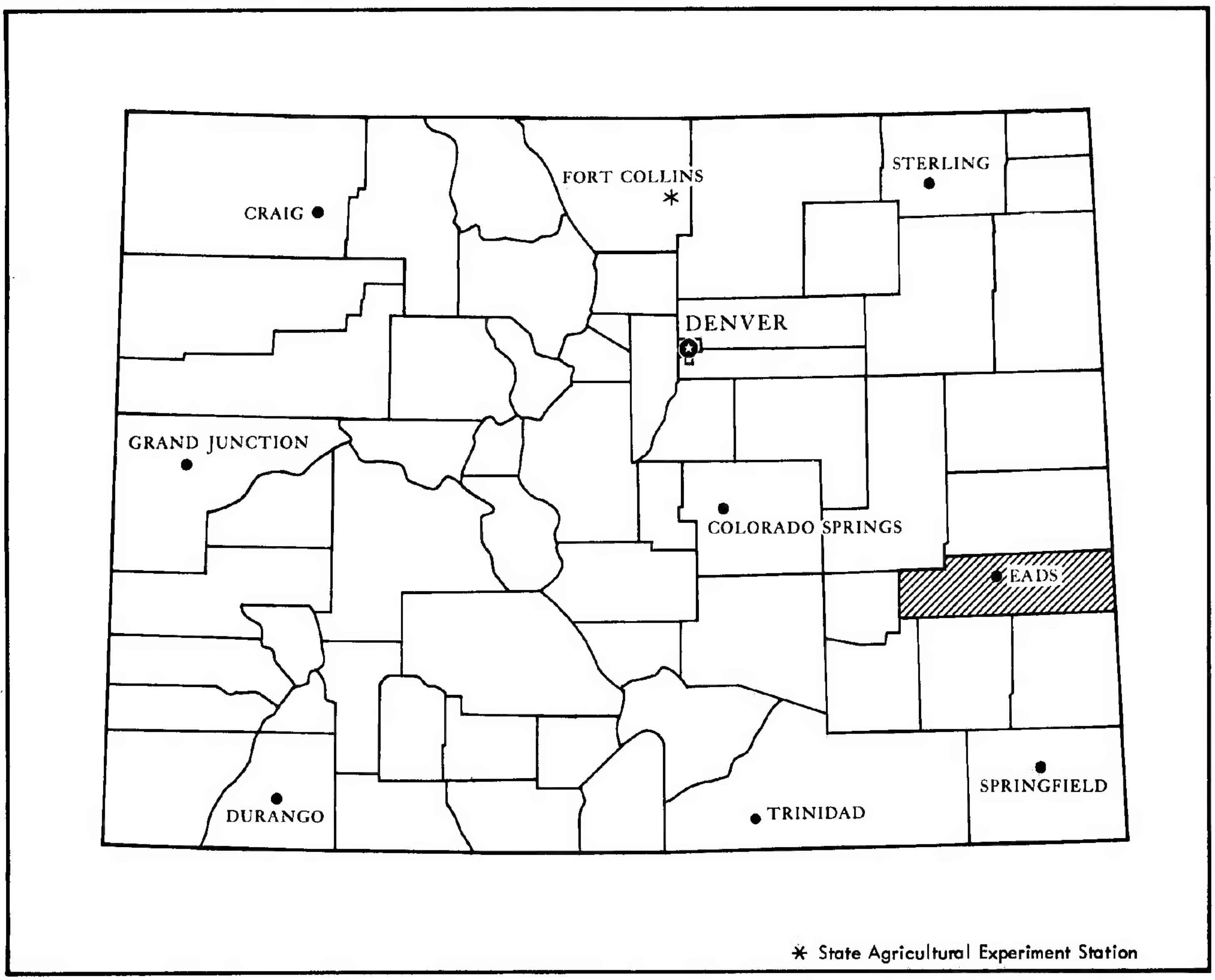
This soil survey has been prepared for many different users. Farmers, ranchers, foresters, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

Robert Halstead
State Conservationist
Soil Conservation Service



Location of Kiowa County in Colorado.

SOIL SURVEY OF KIOWA COUNTY, COLORADO

By David L. Anderson, John G. Lesh, and Donald W. Wickman
Also contributing to the fieldwork were Stanley Albee, David Alstatt, Paul Deutsch, Katie Duquet, Everett Geib, William Hawn, Donald Murray, Darrell Schroeder, William Tripp, and Leslie Williams

United States Department of Agriculture, Soil Conservation Service, in cooperation with Colorado Agricultural Experiment Station

KIOWA COUNTY is a prairie county located in southeastern Colorado. It is rectangular in outline. With Kansas as its eastern boundary, it lies 78 miles long, east and west, and 24 miles wide. Total land area is 1,148,160 acres. Elevation ranges from 3,800 feet in the southeast corner of the county to 4,600 in the northwest corner. The major drainages in the county are Big Sandy and Rush Creeks, which drain the central part of the county; Adobe and Mustang Creeks, which drain the western part; and Wild Horse, Buffalo, and White Woman Creeks, which drain the eastern part.

The population of the county is approximately 2,500, with Eads, the county seat, having a population of about 850.

The soils in Kiowa County are generally good; however, agriculture is limited by the sporadic rainfall pattern. About 59 percent is dryfarmed land; the rest is range. Wheat is the dominant crop; grain sorghum, forage sorghum, and millet also are grown. Much of the dryfarmed land is subject to severe soil blowing. Crop failures are common during years of below average precipitation.

The climate is mild and semiarid. The annual precipitation is about 14 inches. At Eads, however, 2 years in 10 will have less than 10 inches precipitation. The summers are long with hot days and cool nights. In the winter and spring, high velocity windstorms can occur. Dust storms are common from February through April, especially in drier years.

General nature of the county

This section gives general information concerning the county. It discusses climate; physiography, relief, and drainage; history of settlement; natural resources; water supply; and farming.

Climate

Kiowa County is fairly hot in summer and rather cold in winter. Precipitation occurs mainly during the warm period in the form of thunderstorms and occasional hailstorms. Snowstorms occur every winter. Total annual precipitation is adequate for range grasses but is marginal for dryfarmed crops.

Precipitation is sporadic, and for long periods there is little or no rain. Thunderstorms and hailstorms are common, and droughty periods occur every few years. Precipitation ranges from an average of about 12 inches in the western part of the county to about 16 inches in the northeastern corner. Windstorms are common during the winter and spring months. Duststorms often occur from February through April.

Table 1 gives data on temperature and precipitation for the survey area, as recorded at Eads, Colorado, for the period 1951 to 1973. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 32 degrees F, and the average daily minimum temperature is 17 degrees. The lowest temperature on record, which occurred at Eads on January 12, 1963, is -25 degrees. In summer the average temperature is 74 degrees, and the average daily maximum temperature is 90 degrees. The highest recorded temperature, which occured on June 29, 1963, is 110 degrees.

Growing degree days, shown in table 1, are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

Of the total annual precipitation, 11 inches, or 80 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out

of 10, the rainfall in April through September is less than 9 inches. The heaviest 1-day rainfall during the period of record was 6.15 inches at Eads on August 14, 1968. Thunderstorms occur on about 40 days each year; most are in summer.

Average seasonal snowfall is 27 inches. The greatest snow depth at any one time during the period of record was 14 inches. On the average, 3 days have at least 1 inch of snow on the ground, but the number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 35 percent. Humidity is higher at night, and the average at dawn is about 60 percent. The percentage of possible sunshine is 80 in summer and 75 in winter. The prevailing wind is from the south-southeast; however, high-velocity, damaging winds often come from the north or northwest. Average windspeed is highest, 10 miles per hour, in April.

Climatic data in this section were specially prepared for the Soil Conservation Service by the National Climatic Center, Asheville, North Carolina.

Physiography, relief, and drainage

The eastern part of Kiowa County lies within the High Plains section of the Great Plains physiographic province. The western part is in the Colorado Piedmont section. Most of the county is nearly level to gently sloping uplands, where the dominant slope is less than 3 percent. Along intermittent drainways, however, are rolling uplands, where the slopes are more than 3 percent.

In the far western part of the county, along Adobe and Mustang Creeks, is an area of nearly level, broad drainage flats bordered by gently sloping to moderately sloping uplands. This area is underlain in the northern part by dark gray Pierre Shale and in the southern part by yellowish shale of the Niobrara Formation.

The area along Big Sandy and Rush Creeks is bordered by sandhills. This area is nearly level, rolling, or shaped like dunes and has no surface drainage patterns. Where the sand thins and overlies loess hardlands, the area is an important sorghum producer.

The largest part of Kiowa County is a nearly level to gently sloping plain that has been mantled by loess. Loamy material is on the hillsides, and small ridges consist of eolian, sandy material.

All drainage in Kiowa County is toward the Arkansas River with one exception. White Woman Creek, in the northeastern corner, empties into the White Woman Creek basin southeast of Scott City, Kansas. Big Sandy Creek and Adobe Creek are intermittent, but they may have pockets of water or surface flow for a time before disappearing underground. Much of the county is drained into basins that have playa lakes. About 1 percent of the county is occupied by these intermittent lakes. The larger basins, such as Neenoshe, Queens, Sweetwater, and Blue Lakes, have been used to store water for irrigation.

History of settlement

The area that is now Kiowa County was obtained by the United States with the purchase of the Louisiana Territory in 1803. Among the early explorers was Major Stephen H. Long, who called the plains "The Great American Desert," almost wholly unfit for cultivation. The original inhabitants of Kiowa county were the Kiowa, Apache, Arapahoe, and the Cheyenne Indians.

When the first settlers came, the plains abounded in bison, deer, antelope, and elk. Early settlers reported seeing large herds of wild horses.

Many of the pioneers came to Kiowa County from eastern states to escape the Civil War. Grassland was first plowed between 1889 and 1890. Large areas, however, were not plowed until after World War II. "Few trees dotted the plains in the old days; but there were plenty of sagebrush, soap weed, cacti, and wild flowers mixed with buffalograss" (*4*).

Governor Job A. Cooper created the new County of Kiowa on April 11, 1889. Settlers arrived in the new county in various ways; by covered wagon, by horseback, and by railroad.

Most of the early settlers were farmers. The walking plow, the old wooden harrow, the old lay-down cultivator and the hoe were their farming tools. As the plowing was done, someone would drop seeds in every third row; or the seed was broadcasted and harrowed into the ground (*4*).

At the turn of the century, Kiowa County was more thickly settled than it is now. Just about every quarter section in some areas had someone living on it; however, many farmers left during the droughts of the thirties and the fifties.

One of the tragedies which mar the settlement of the West took place in Kiowa County. On the morning of November 29, 1864, Colonel J. M. Chivington surprised and attacked Chief Black Kettle's band of Cheyenne Indians as they were camped along Big Sandy Creek. One hundred and five women and children and 28 Indian men were killed that day. Chief Black Kettle escaped, however, only to have the same thing happen on Wichita Creek in Oklahoma Territory.

Natural resources

Soil, underground water, oil, natural gas, and native vegetation are the major natural resources of Kiowa County. The soils in Kiowa County are generally good; however, the climate limits production.

About one-half of the native vegetation has been plowed and the soil has been planted to dryfarmed wheat. Native grass is suffering from overgrazing in many areas of the county. Proper management could increase the productivity of the rangeland. Maintaining the native vegetation can also be helpful in maintaining the soil by minimizing soil blowing.

The production of oil and natural gas has been expanding in the last few years.

Water supply

Irrigation in Kiowa County is limited by the unavailability of a suitable quantity of water.

The main aquifer in Kiowa County is located in the alluvium of Rush and Big Sandy Creeks. Irrigation water is applied mainly by the sprinkler method. The ground water is restored in this area by precipitation.

In the southeastern part of the county, a few wells are tapping the Ogallala Formation. The water table, however, is lowering, so expanded irrigation is questionable. Water is available along Adobe Creek, but the slow permeability of the aquifer makes large quantities of irrigation water difficult to obtain. The soils along Adobe Creek are generally so high in salt content that large quantities of water would be required to farm.

In some areas water collected in drainage basins can be used for irrigation. In dryer years, however, water would be limited.

In some areas it is difficult to obtain water of suitable quality for livestock and domestic use. This is especially true in the areas where shale lies near the surface, as in the western part of the county. To help solve this problem, water supplies should be developed from moisture stored in valley fill when possible (*3*). Future extensive exploitation of ground water may cause such problems as depletion of storage, decreasing yields, and worsening of water quality (*3*).

Because obtaining water is a problem, it has become popular to pipe water from a good well for several miles to areas where water is unavailable. This practice has helped to use the native vegetation in Kiowa County more efficiently.

Farming

Farming is the number one industry of Kiowa County. Dryfarming is the largest enterprise, followed by ranching and irrigated farming. The principal dryfarmed crops are wheat, about 196,000 acres; grain sorghum, about 23,000 acres; millet and forage sorghums, about 5,000 acres (*7*).

According to the 1974 Census of Agriculture, 383 farms in Kiowa County have an average size of 2,600 acres. The average age of farmers is 51 years. The total number of farms is decreasing while the size of farms is enlarging. As farms become larger, the ability to properly manage each acre often decreases, because this type of farming requires large implements as well as large amounts of operating capital. A large part of Kiowa County is owned by nonresidents. Timely tillage is especially important in the type of climate that Kiowa County has. To perform the needed practices, the operator must be available at all times. Most farmers live in communities such as Eads, Sheridan Lake, and Haswell. Areas outside of these communities are sparsely populated.

About 14,000 acres are irrigated. The dominant irrigated crops are corn, alfalfa, and wheat. Irrigation water is limited, and the number of acres being irrigated is decreasing.

Ranching operations comprise about 40 percent of Kiowa County. The cow-calf-yearling operation is the dominant type. In 1974, there was about 43,000 head of cattle and calves, which was about 10,000 head less than in 1969.

The success or failure of farming and ranching is determined by the amount of precipitation.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

After a guide for classifying and naming the soils was worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observa-

tions of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland and woodland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the back of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Each map unit is rated for *cultivated farm crops, grazing, wildlife, and urban uses*. Cultivated farm crops are those grown extensively by farmers in the survey area. Urban uses include residential, commercial, and industrial developments. Wildlife includes rangeland, openland, and wetland wildlife habitat.

Dominantly nearly level to strongly sloping soils formed in material derived from shale

The soils in this group are on flood plains, terraces, and upland plains. The native vegetation consists of short grasses and salt-tolerant grasses and shrubs. These soils are mainly in the western part of the county. They are used mainly for rangeland.

Three map units are in the group, and they make up about 8 percent of the survey area.

1. Absted-Limon

Nearly level, well drained, deep soils; on terraces and flood plains

This map unit consists of soils on terraces and in drainageways along Adobe and Mustang Creek. These soils are in the western part of the county. Slope is 0 to 2 percent.

This unit makes up about 4 percent of the county. It is about 50 percent Absted soils, 35 percent Limon soils, and 15 percent soils of minor extent.

Absted soils are on terraces that are subject to rare flooding. They have a yellowish brown surface layer. They are clay throughout. The Absted soils have a high content of sodium and salts.

Limon soils are in drainageways that are flooded during intensive rains. They have a brown surface layer. They are clay throughout. They are less affected by salt than the Absted soils.

Minor soils in this unit are the medium textured Haverson soils in drainageways and the sodic Arvada and Cadoma soils, which are on ridges. The Arvada and Cadoma soils are underlain by shale at a depth of 20 to 40 inches.

This unit is used for rangeland.

The soils in this unit have good potential for rangeland. If properly managed they produce abundant forage, but good quality water for livestock is sometimes difficult to find. The soils are limited for urban development by high shrink-swell potential, flooding, slow permeability, and low strength. Because of the high salt content and slow permeability, these soils are unsuited to cultivated crops.

This unit has fair potential for rangeland wildlife, such as antelope, cottontail rabbit, jackrabbit, kit fox, and coyote. Proper management of livestock grazing is necessary if livestock and wildlife share the range. Watering facilites for livestock are important and are used by various wildlife species. Types of fences that permit unrestricted movement of antelope could be installed.

2. Cadoma-Midway

Nearly level to strongly sloping, well drained, moderately deep and shallow soils; on upland plains

This map unit consists of soils that are on hillsides and ridges of upland plains. These soils are over dense gray shale. They are in the western part of the county. The soils are dissected by numerous drainageways and are characterized by rapid runoff. Slope is 1 to 12 percent.

This unit makes up about 1 percent of the county. It is about 60 percent Cadoma soils, 30 percent Midway soils, and 10 percent soils of minor extent.

Cadoma soils are on hillsides of upland plains. They have a yellowish brown surface layer and are clay throughout. Shale is at a depth of about 34 inches. The Cadoma soils are affected by salt and alkali.

Midway soils are on convex ridges of upland plains. They have a light yellowish brown surface layer and are clay throughout. Shale is at a depth of about 10 inches.

Minor soils in this unit are the deep Limon, Absted, and Arvada soils. These soils are in drainageways and on foot slopes.

This unit is used for rangeland.

The soils have good potential for rangeland. If properly managed they produce adequate forage. Sometimes it is difficult to provide good quality water for livestock, because the thickness of the underlying shale is a limitation to digging wells. The soils are limited for urban development by depth to bedrock, high shrink-swell potential, slow permeability, and low strength. They are not suited to cultivated crops because of high salt content, limited available water capacity, hazard of erosion, and slow permeability.

This unit has poor potential for rangeland wildlife, such as antelope, cottontail rabbit, jackrabbit, kit fox, and coyote. Proper management of livestock grazing is necessary if livestock and wildlife share the rangeland. Watering facilities for livestock are important and are used by various wildlife species. Fencing that permits unrestricted movement of antelope could be used.

3. Singerton-Pultney

Nearly level to moderately sloping, well drained, deep and moderately deep soils; on plains and side slopes of uplands

This map unit consists of soils on side slopes and uplands. These soils are over calcareous and gypsiferous shale. These soils are primarily in the western part of the county between the cities of Haswell and Arlington. Slope is 1 to 10 percent.

This unit makes up about 3 percent of the county. It is about 45 percent Singerton soils, about 35 percent Pultney soils, and 20 percent soils of minor extent.

Singerton soils are on smooth uplands. They have a surface layer of light yellowish brown loam and an underlying layer of clay loam. The Singerton soils have a high content of calcium carbonate and calcium sulphate.

Pultney soils are on upland side slopes. They have a light yellowish brown surface layer. The surface layer and underlying layer are clay loam. Shale is at a depth of about 25 inches. The Pultney soils have a high content of calcium carbonate and calcium sulphate.

Minor soils in this unit are the deep Stoneham and Kim soils, which have a lower content of salts, and the Shingle soil, which is less than 20 inches deep to shale.

This unit is used for rangeland. A few acres are cropped to dryfarmed wheat; however, cropping of these soils is unsuccessful.

The soils have good potential for rangeland. If properly managed, they produce adequate forage. In planning the use of these soils for urban development, depth to bedrock, moderately slow permeability, moderate shrink-swell potential, and moderately low strength need to be considered. These soils are not suited to cultivated crops because of the moderate salinity, the high hazard of erosion, and the limited available water capacity of the Pultney soil.

This unit has fair potential for rangeland wildlife, such as antelope, cottontail rabbit, jackrabbit, kit fox, and coyote. Proper grazing management is necessary if livestock and wildlife share the rangeland. Watering facilites for livestock are important and are used by various wildlife species. The type of fences that permits unrestricted movement of antelope could be installed.

Dominantly nearly level to gently sloping soils that formed in loess

The soils in this group are on upland flats, plains, and low hillsides. The native vegetation consists of short and mid grasses. The soils are throughout the county but are most common in the central and eastern part. They are used mainly as rangeland and dry cropland.

Three map units are in this group, and they make up about 49 percent of the survey area.

4. Baca-Wiley

Nearly level, well drained, deep soils; on flats and plains of uplands

This map unit consists of flatlands that are northwest and southeast of the city of Eads. Slope is 0 to 2 percent.

This unit makes up about 12 percent of the county. It is about 50 percent Baca soils, about 40 percent Wiley soils, and 10 percent soils of minor extent.

Baca soils are in slightly concave parts of flats in uplands. They have a surface layer of brown clay loam, a subsoil of clay and silty clay loam, and a substratum of silt loam.

Wiley soils are at slightly higher positions on the landscape than Baca soils. They have a surface layer of brown silt loam, a subsoil of silty clay loam, and a substratum of silt loam.

Minor soils in this unit are the medium textured Stoneham soils and the light colored Colby soils on ridges and hillsides.

This unit is used mainly for dryfarming, but some areas are used for rangeland.

If soil blowing is controlled, the soils in this unit have good potential for farming. Low strength and moderate shrink-swell potential are the main limitations for urban development.

This unit has fair potential for openland wildlife, such as pheasant, cottontail rabbit, and mourning dove. If soils are cropped, favorable habitat can be established by providing cover for nesting and escape. For pheasant, undisturbed nesting cover is vital. Planting trees and shrubs along fence lines, roadsides, and streams can provide habitat for wildlife.

5. Norka-Richfield

Nearly level, well drained, deep soils; on flats and smooth hillsides of uplands

This map unit consists of soils on flats and smooth hillsides of uplands. These soils are east of Sheridan Lake in the eastern part of the county. Slope is 0 to 2 percent.

This unit makes up about 16 percent of the county. It is about 45 percent Norka soils, 30 percent Richfield soils, and 25 percent soils of minor extent.

Norka soils are on flats and smooth hillsides. They are at slightly higher positions on the landscape than Richfield soils. They have a surface layer of brown silt loam, a subsoil of silty clay loam, and a substratum of silt loam.

Richfield soils are in slightly concave parts of the landscape. They have a surface layer of dark brown silt loam, a subsoil of silty clay loam, and a substratum of silt loam.

Minor soils in this unit are Goshen soils in drainageways, Colby and Wiley soils on ridges, and Canyon soils on steep escarpments.

This unit is used mainly for dryfarmed crops, but some areas are used as rangeland.

This unit has good potential for cultivated crops if soil blowing and water erosion are controlled. The soils in this unit are among the best for producing wheat in the county. The main limitations to urban uses are low strength and shrink-swell potential.

This unit has fair potential for openland wildlife, such as pheasant, cottontail rabbit, and mourning dove. If soils are cropped, favorable habitat can be established by providing cover for nesting and escape. For pheasant, undisturbed nesting cover is vital. Planting trees and shrubs along fence lines, roadsides, and streambeds is beneficial to wildlife.

6. Wiley-Colby

Nearly level to gently sloping, well drained, deep soils; on upland plains

This map unit consists of soils on hillsides and convex ridges of upland plains. The soils are in the central part of the county. Slope is 0 to 3 percent.

This unit makes up about 21 percent of the county. It is about 50 percent Wiley soils, 30 percent Colby soils, and 20 percent soils of minor extent.

Wiley soils are on plains and smooth hillsides of uplands. They are at a slightly lower position on the landscape than Colby soils. They have a brown silt loam surface layer, a silty clay loam subsoil, and a silt loam substratum.

Colby soils are on rolling plains and in severely eroded areas of uplands. They have a surface layer of pale brown silt loam and an underlying layer of silt loam.

Minor soils in this unit are the fine textured and moderately fine textured Baca soils in drainageways and the medium textured Stoneham soils.

This unit is used for dryfarmed crops and for rangeland.

This unit has fair potential for farming if soil blowing and water erosion are controlled. The use of these soils for urban development is limited by moderately low strength, moderate shrink-swell potential, and moderately slow permeability. These limitations need to be considered in planning.

This unit has fair potential for openland wildlife, such as pheasant, cottontail rabbit, and mourning dove. If soils are cropped, favorable habitat can be established by providing cover for nesting and escape. For pheasants, undisturbed nesting cover is vital and needs to be included in plans for habitat development. Planting trees and shrubs along fences, roadsides, and streambanks also helps encourage wildlife. Such rangeland wildlife as antelope, jackrabbit, and scaled quail can be encouraged by grazing management, development of sources of water, and installing fencing that permits unrestricted movement of antelope.

Dominantly nearly level to strongly sloping soils that formed in loamy material

The soils in this group are on upland plains and side slopes. The native vegetation consists of short and mid grasses. The soils are mainly in the central and western part of the county. They are used mainly as dry cropland and rangeland.

Three map units are in this group, and they make up about 28 percent of the survey area.

7. Fort Collins-Stoneham-Vona

Nearly level to strongly sloping, well drained, deep soils; on plains and side slopes of uplands

This map unit consists of soils on flats, hillsides, and ridges of uplands. These soils are mainly in the central

and southwestern part of the county. Slope is 0 to 12 percent.

This unit makes up about 13 percent of the county. It is about 35 percent Fort Collins soils, 30 percent Stoneham soils, 20 percent Vona soils, and 15 percent soils of minor extent.

The nearly level Fort Collins soils are on flats, on smooth hillsides, and in drainageways. They have a brown surface layer of sandy loam, a subsoil of clay loam, and a substratum of loam.

Stoneham soils are on flats and smooth hillsides of uplands. They have a surface layer of brown loam, a subsoil of clay loam, and a substratum of loam.

Vona soils are on convex ridges. They have a surface layer of brown sandy loam and a subsoil and substratum of sandy loam.

Minor soils in this unit are the medium textured Kim soils and the Wiley soils, which formed in loess.

This unit is used for dryfarmed crops and for rangeland.

The Fort Collins soils have good potential for farming if soil blowing is controlled. The Stoneham soils have fair potential for farming; however, the Vona soils are severely limited for farming by the hazard of soil blowing. When planning for urban development on the Fort Collins and Stoneham soils, moderate shrink-swell potential, moderately low strength, and moderately slow permeability are factors to be considered.

This unit has fair potential for such openland wildlife as pheasant, cottontail rabbit, and mourning dove and has a fair potential for such rangeland wildlife as antelope, jackrabbit, and scaled quail. If soils are cropped, favorable habitat can be established by providing cover for nesting and escape. For pheasants, undisturbed nesting cover is vital and needs to be included in plans for habitat development. Planting trees and shrubs along fences, roadsides, and streams also helps encourage wildlife. Rangeland wildlife can be encouraged by proper grazing management, developing water sources, and installing the type of fencing that permits unrestricted movement of antelope.

8. Stoneham-Kim

Nearly level to strongly sloping, well drained, deep soils; on upland plains

This map unit is on plains, hillsides, and ridges of uplands. These soils are primarily in the western part of the county. Slope is 0 to 12 percent.

This unit makes up about 12 percent of the county. It is about 40 percent Stoneham soils, 35 percent Kim soils, and 25 percent soils of minor extent.

Stoneham soils are on flats and smooth hillsides of uplands. When cropped most of the Stoneham soils have become severely eroded. These soils have a surface layer of brown loam, a subsoil of clay loam, and a substratum of loam.

Kim soils are on upland plains that have been severely eroded and are on ridges. They have a surface layer of brown loam and an underlying layer of sandy clay loam. In eroded areas the surface layer is pale brown.

Minor soils in this unit are primarily the Manzanola soils, which have a higher content of clay. They are in drainageways and on broad flats.

This unit is used for dryfarmed crops and rangeland.

These soils have poor potential for dryfarming. They are mainly located in the dryer parts of the county and have a high hazard of erosion. These soils are best used for rangeland. Intense management is required to control soil blowing and water erosion. When planning the use of these soils for urban development, moderate shrink-swell potential, moderately low strength, and moderately slow permeability are factors to be considered.

This unit has fair potential for such openland wildlife as pheasant, cottontail rabbit, and mourning dove and fair potential for such rangeland wildlife as antelope, jackrabbit, and scaled quail. If the soils are cropped, favorable habitat can be established by providing cover for nesting and escape. For pheasants, undisturbed nesting cover is vital and needs to be included in plans for habitat development. Planting trees and shrubs along fences, roadsides, and streambanks also helps encourage wildlife. Rangeland wildlife can be encouraged by proper grazing management, developing water sources, and installing types of fencing that permit unrestricted movement of antelope.

9. Sundance-Olney

Nearly level, well drained, deep soils; on upland plains

This map unit consists of soils that are in a transitional area between the sandhills and hardlands, which are deep, loamy areas, in the central part of the county. Slope is 0 to 2 percent.

This unit makes up about 3 percent of the county. It is about 65 percent Sundance soil, about 20 percent Olney soil, and 15 percent soils of minor extent.

Sundance soil is on upland plains. It has a surface layer of yellowish brown, loamy sand. The upper part of the subsoil is sandy loam, and the lower part is clay loam. The substratum is silt loam.

Olney soil is on upland plains and in areas that are between dunes in the sandhills. It has a brown surface layer of loamy sand, a subsoil of sandy clay loam, and a substratum of sandy loam.

Minor soils in this unit are the Fort Collins soils, which have a sandy loam surface layer, and the Bijou soils, which have a sandy loam subsoil and are on ridges.

This unit is used for dryfarmed crops. These soils are the only ones in the county that can be annually cropped successfully with grain sorghum.

The soil has good potential for farming; however, soil blowing must be controlled. When developing the soil for urban uses, moderate shrink-swell potential, moderately

low strength, and moderately slow permeability of the Sundance soil need to be considered.

This unit has fair potential for such openland wildlife as pheasant, cottontail rabbit, and mourning dove. Favorable habitat can be established by providing cover for nesting and escape. For pheasant, undisturbed nesting cover is vital and needs to be included in plans for habitat development. Trees and shrubs planted along fences, roadsides, and streambanks also help encourage wildlife. This unit is also important as a feeding area for Canadian geese, which use the lakes in Kiowa County.

Dominantly nearly level to moderately sloping soils that formed in sandy material

The soils in this group are on flood plains, terraces, and sandhills. The native vegetation consists of mid and tall grasses and sand sagebrush. The soils are in the east-central part of the county. They are used mainly for rangeland.

Two map units are in this group, and they make up about 15 percent of the survey area.

10. Valent-Bijou

Nearly level to moderately sloping, somewhat excessively drained, deep soils; on sandhills

This unit consists of soils in the sandhills that parallel Rush and Big Sandy Creek. It has a poorly defined drainage pattern. Slope is 0 to 10 percent.

This unit makes up about 13 percent of the county. It is about 45 percent Valent soils, 40 percent Bijou soils, and 15 percent soils of minor extent.

Valent soil is on ridges shaped like dunes, which commonly extend in a northwesterly direction. It has a brown, loamy sand surface layer and a sand underlying layer.

Bijou soil is in areas between dunes. It has a brown surface layer of loamy sand, a subsoil of sandy loam, and a substratum of sand.

Minor soils in this unit are the heavier textured Olney soil and Blownout land. In sand hills, the soil blows in old, abandoned fields and areas heavily grazed by livestock. This causes scars that are difficult to revegetate.

This unit is used almost entirely for rangeland. If properly managed, it is one of the best grass-producing areas in the county. The soils in this unit have good potential for urban uses. The extreme soil blowing hazard and low available water make these soils unsuited to dryfarming.

This unit has fair potential for such rangeland wildlife as antelope, jackrabbit, cottontail rabbit, scaled quail, and coyote. Proper management of livestock grazing is necessary if livestock and wildlife share the rangeland. Watering facilities for livestock are also important and are used by various wildlife species. Fencing should be the type that permits unrestricted movement of antelope.

11. Bankard-Fluvaquents

Nearly level, somewhat excessively drained to poorly drained, deep soils; on terraces and flood plains

This unit consists of soils on flood plains and terraces along Rush and Big Sandy Creeks. Slope is 0 to 1 percent.

This unit makes up about 2 percent of the county. It is about 40 percent Bankard soils, 30 percent Fluvaquents, and 30 percent soils of minor extent.

Bankard soils are on terraces and flood plains and are subject to flooding. They have a surface layer of brown loamy fine sand. The underlying layer is loamy sand to gravelly sand that is stratified with thin layers of sandy loam.

Fluvaquents are on flood plains. They also are subject to flooding and have a seasonal high water table. The texture, depth of the seasonal high water table, and thickness of layers are extremely variable. Texture ranges from sand to clay; however, it is generally finer along Rush Creek. During dry periods the water table may be deep, but in wet periods, usually in the spring, water is on the surface in some areas.

Minor soils in this unit are the Haverson soils that formed in loamy alluvium, the Glenberg soils that formed in sandy loam alluvium, the Limon soils that formed in clayey alluvium, and the Keyner Variant that formed in sandy material over clayey material. The Keyner Variant is saline-alkali.

This unit is used almost entirely for rangeland. A few acres are being irrigated, and a few acres of the included Haverson soil are dryfarmed.

This unit is not suited to dryfarming. It is also not suited for urban development because of the flooding and the seasonal high water table.

Wetland wildlife, especially waterfowl, use the Fluvaquents part of this unit. The wetness of Fluvaquents produces wetland plants that provide nesting and protective cover, as well as some food for waterfowl. Because these soils are near cropland and rangeland, where wildlife obtain much of their food and cover, they are valuable to both wetland and rangeland wildlife. These soils provide habitat that is excellent cover for deer. Openland wildlife, especially pheasant, also use these areas for cover and nesting. Management of wildlife includes prevention of overgrazing by livestock, protection from unplanned fire, and prevention of draining wetland habitat. Where livestock are present, these valuable wildlife areas should be fenced to prevent overuse by livestock and unwanted encroachment.

Broad land use considerations

The land in Kiowa County is used dominantly for farming and ranching. The major change has been converting land from native rangeland to dry cropland. Only a small

percentage of the land is in irrigated cropland, and that percentage is not increasing.

The potential for additional irrigation is limited because of the unavailability of underground water or surface water. Areas of the Bankard-Fluvaquents unit are being irrigated by both sprinkler and ditch irrigation. Flooding, very high hazard of soil blowing, and wetness are the main soil limitations. The Baca-Wiley, Norka-Richfield, Wiley-Colby, Fort Collins-Stoneham-Vona, Stoneham-Kim, and Sundance-Olney map units have good potential for both sprinkler and ditch irrigation if water is available. Areas in the Valent-Bijou map unit have good potential for sprinkler irrigation if water is available.

The most extensively dryfarmed areas are the Sundance-Olney, Norka-Richfield, and Baca-Wiley units. In these areas, the potential for additional nonirrigated cropland is limited to small, scattered tracts generally near farmsteads. In these units, the main limitation is soil blowing.

Large areas in the Wiley-Colby and Fort Collins-Stoneham-Vona map units have the potential of being converted to dry cropland. Intensive management is needed, however, on these soils because of the hazard of soil blowing and water erosion. Productivity could be increased by the use of conservation farming.

Nearly all of the soils are well suited as rangeland. The potential for continued productivity of the rangeland can be maintained and improved by proper management.

Map units that are well suited as rangeland are the Absted-Limon, Cadoma-Midway, Singerton-Pultney, Stoneham-Kim, Valent-Bijou, and the Bankard-Fluvaquents.

Map units unfavorable for urban development are not extensive in the county. The Bankard-Fluvaquents unit is subject to flooding; and the Absted-Limon unit is also susceptible to rare flooding. The Absted-Limon and Cadoma-Midway units have high shrink-swell potential.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have a profile that is almost alike make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Baca loam, 0 to 1 percent slopes, is one of several phases within the Baca series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Baca-Wiley complex, 0 to 2 percent slopes, is an example.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Blowout land is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 4, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

1—Absted clay, 0 to 1 percent slopes. This deep, well drained soil is nearly level. It is a saline-alkali-affected soil. It is on terraces along Mustang and Adobe

Creeks. It formed in clayey alluvium derived from shale. Slopes are smooth and are as much as 1 mile long. The average annual precipitation is about 13 inches.

Typically, the surface layer is yellowish brown clay about 3 inches thick. The subsoil extends to a depth of 16 inches. It is brown and grayish brown clay. The substratum, to a depth of 60 inches, is brown clay. The lower part of the subsoil and the substratum have a high content of sodium salts and other salts. The soil is calcareous throughout.

Included with this soil in mapping are small areas of Arvada and Limon soils. The Arvada soils occur as slick spots. The Limon soils are in drainageways. Included areas make up about 15 percent of a mapped area.

Permeability of this Absted soil is slow. Available water capacity is moderate. Effective rooting depth is about 60 inches. Where this soil is under native vegetation, the average annual wetting depth is about 20 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is high. This soil is subject to rare flooding during heavy rains in spring and summer.

This soil is used as rangeland, and it is well suited to this use. At times it receives additional water from adjacent uplands. This is beneficial to forage production. The native vegetation is mainly alkali sacaton, blue grama, western wheatgrass, and lesser amounts of switchgrass. When the rangeland condition deteriorates, the proportion of pricklypear, snakeweed, annuals, and other less desirable plants increases. Large bare spots are present in areas where livestock congregate. These spots are highly susceptible to erosion. Control of intensity and distribution of grazing can be achieved by adjusting the stocking rate, fencing, and properly locating livestock watering facilities. Native grass is very difficult to reestablish on this soil. The most successful method of reseeding grass is to plant the seed by drill and to pit the area. The pitting, making shallow pits to hold water, should be done at a 45 degree angle to the holes that have been drilled for seed. Installing diversions to help spread runoff water is highly beneficial to the vegetation.

This soil is unsuited to cultivated crops because of the high salt content. Large quantities of irrigation water would be needed to leach the soil of salt and reclaim it.

This soil is poorly suited to homesite development and to most urban uses. The main limitations for these uses are the hazard of flooding, high shrink-swell potential, slow permeability, and low strength. Flooding is rare, so water usually does not accumulate to a great depth. Installing embankments and diversions or elevating buildings above the water level can avoid the hazard of flooding. Standard septic tank absorption fields do not function properly because of slow permeability. Foundations need to be designed to compensate for the shrinking and swelling of the soil as it alternately wets and drys. Because excessive wetness in the soil material around buildings can damage foundations, drainage is needed to carry water away from buildings. Lawns and gardens are difficult to establish and maintain. The engineering measures needed to overcome the limitations of this soil are costly.

This soil is in capability subclass VIs.

2—Arvada-Absted clays, 0 to 2 percent slopes. This complex consists of deep, well drained, soils that are nearly level. These saline-alkali-affected soils are on terraces and in drainageways. These soils formed in clayey alluvium derived primarily from Pierre Shale. The average annual precipitation is about 13 inches.

This complex is about 50 percent Arvada soil and about 45 percent Absted soil. The Arvada soil has slick spots, but the Absted soil does not.

Included with this complex in mapping are small areas of Cadoma soils. Cadoma differs from both these soils in that shale is at a depth of 20 to 40 inches. It is on small knolls and foot slopes.

Typically, in the Arvada soil the upper 2 inches are pale brown and brown clay. The subsoil extends to a depth of 14 inches. It is brown clay and clay loam. The substratum, to a depth of 60 inches or more, is pale brown clay and clay loam. The soil has a high content of sodium salts and other salts and is calcareous throughout.

The Arvada soil has slow permeability. Available water capacity is low because of excess salts. Effective rooting depth is 60 inches or more. Where the soil is under native vegetation, the average annual wetting depth is about 12 inches. Surface runoff is medium, and the hazard of erosion is moderate. The hazard of soil blowing is high. This unit is subject to rare flooding during heavy spring and summer rains.

Typically, the Absted soil has a surface layer of yellowish brown clay about 3 inches thick. The subsoil extends to a depth of 16 inches. It is brown and grayish brown clay. The substratum, to a depth of 60 inches or more, is brown clay. The lower part of the subsoil and substratum have a high content of sodium salts and other salts. The soil material is calcareous throughout.

The Absted soil has slow permeability. Available water capacity is moderate. Effective rooting depth is about 60 inches. Where this soil is under native vegetation, the average annual wetting depth is about 20 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is high. This soil is subject to rare flooding during heavy rains in spring and summer.

These soils are used as rangeland and are well suited to this use. The native vegetation consists predominantly of alkali sacaton, western wheatgrass, and blue grama. When overgrazed, saltgrass, buffalograss, rabbitbrush, galleta, and greasewood replace the sacaton and other grasses and shrubs. These soils are difficult to revegetate; therefore, careful management of livestock grazing is especially important. Where rangeland is in poor or fair condition, chiseling or pitting improves plant cover that has been depleted. Greasewood and rabbitbrush need to

be controlled where they have increased to a point that they interfere with forage production and grazing distribution.

These soils are unsuited to farming because of high content of salt. Large quantities of irrigation water would be needed to leach the soil of salt for reclamation.

These soils are poorly suited to homesites and to most urban uses, because they are limited by slow permeability, high shrink-swell potential, and the low strength. They may be subject to shallow flooding after heavy rains. Special hydrologic studies are needed to determine flooding hazard. Standard septic tank absorption fields do not function properly because of the slow permeability. Lawns and gardens are difficult to establish and maintain because of the high sodium content in the soils. Engineering measures to overcome the limitations are costly. If possible, a more suitable area should be selected as a building site.

This complex is in capability subclass VIIs.

3—Baca loam, 0 to 1 percent slopes. This deep, well drained soil is nearly level. It is on flats and swales of uplands. It formed in loess. The average annual precipitation is about 15 inches.

Typically, the surface layer is brown loam about 6 inches thick. The subsoil extends to a depth of 29 inches. It is brown clay grading to very pale brown silty clay loam. The substratum, extending to 60 inches or more, is very pale brown silt loam. The soil is calcareous below a depth of 18 inches.

Included with this soil in mapping are small areas of Haverson soils that are on bottomland. These soils are more frequently flooded than Baca soils.

This Baca soil has moderately slow permeability. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average wetting depth is about 30 inches. Surface runoff is slow, and the hazard of erosion is slight. The soil blowing hazard is moderate. This soil is subject to rare flooding during heavy rains.

This soil is used for rangeland and dryfarmed crops. It is well suited to dryfarming if soil blowing is controlled. The main dryfarmed crop is wheat. Some millet, forage sorghum, and grain sorghum are grown.

If these soils are dryfarmed, the main concerns in management are to conserve soil moisture and to control soil blowing. Management that controls soil blowing and conserves moisture includes maintaining a cover of plants or stubble at all times, maintaining a cloddy surface, and using minimum tillage and stripcropping. A minimum of 1,300 pounds of stubble needs to be retained on the surface at planting time. Investigations are needed at the site before terraces can be used. Terraces can be destroyed because this soil is subject to flooding. When weeding, only equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. This can be done in the fall, and a preemergence herbicide or a contact herbicide can be used to kill weeds. Chiseling improves infiltration of water and penetration of roots into the soil. Crops respond to nitrogen fertilizer, but nitrogen should only be added when adequate moisture is available.

The soil is well suited to range. The native vegetation is mainly blue grama, western wheatgrass, and galleta. When the rangeland deteriorates, the proportion of threeawn, sand dropseed, pricklypear, and other less desirable plants increases.

Grazing intensity needs to be managed to leave 50 percent of the forage standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Reseeding is suitable in areas where vegetation has been destroyed by cultivation or overgrazing. If this soil was planted to sorghum or small grain the previous year, seeding grass into the stubble helps protect the seedlings from wind damage. The seed is planted by a drill adapted to grass. Suitable plants for seeding are blue grama, sideoats grama, and western wheatgrass. Installing water facilities, fencing, and using deferred grazing improve or help maintain the condition of the rangeland. Contour furrowing or pitting can be used in areas where rangeland is in poor or fair condition.

This soil is poorly suited to homesites and to most urban uses. Flooding, moderately slow permeability, and moderate shrink-swell potential are limiting soil features. Careful consideration of the flooding hazard precludes any development. In some areas, however, flooding is shallow and of short duration. In these areas, the flooding hazard can be minimized by elevating the floor of a building above the water level, installing diversions, and protecting basements from flooding.

This soil is in capability subclasses IVw, dryland, and IIw, irrigated.

4—Baca-Wiley complex, 0 to 2 percent slopes. This complex consists of deep, well drained soils that are nearly level. These soils are on plains, flats, and swales of uplands. They formed in loess. Slopes are smooth and may be over 1 mile in length. The average annual precipitation is about 15 inches.

This complex is 50 percent Baca soil and about 40 percent Wiley soil. The more nearly level Baca soil is slightly concave, and the Wiley soil is slightly convex.

Included with this complex in mapping are small areas of Norka, Richfield, and Colby soils. Included areas make up about 10 percent of a mapped area.

Typically, the Baca soil has a surface layer of brown clay loam about 4 inches thick. The subsoil extends to a depth of 25 inches. It is brown clay grading to very pale brown silty clay loam. The substratum, to a depth of 60 inches or more, is very pale brown silt loam. The soil material is calcareous below a depth of 11 inches.

The Baca soil has moderately slow permeability. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 20 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is high.

Typically, the Wiley soil has a surface layer of brown silt loam about 5 inches thick. The subsoil extends to a depth of 30 inches. The upper 11 inches is pale brown silty clay loam, and the lower 14 inches is pale brown silt loam. The substratum, to a depth of 60 inches or more, is pale brown silt loam. The soil is typically calcareous throughout, but the upper few inches may be leached.

The Wiley soil has moderate permeability. Available water capacity is high. Effective rooting depth is 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 18 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is high.

These soils are used for dryfarmed crops and as rangeland. They are well suited to dryfarmed crops, if soil blowing is controlled. The main crop is wheat, but millet and forage sorghum are also grown.

If these soils are dryfarmed, the main concerns in management are to conserve soil moisture and to control soil blowing. Management that controls soil blowing and conserves moisture includes maintaining a cover of plants or stubble at all times, maintaining a cloddy surface, and using minimum tillage, terracing, and stripcropping. A minimum of 1,600 pounds of stubble needs to be retained on the surface at planting time. When weeding, only equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. This can be done in the fall and a preemergence herbicide or a contact herbicide can be used to kill weeds. Chiseling improves infiltration of water and penetration of roots into the soil. Crops respond to nitrogen fertilizer, but nitrogen should only be added when adequate moisture is available.

These soils are well suited to rangeland. The native vegetation is mainly blue grama, western wheatgrass, galleta, and sideoats grama. When the rangeland deteriorates, the proportion of threeawn, sand dropseed, pricklypear, and other less desirable plants increases.

Grazing intensity should be managed to leave 50 percent of the forage standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Reseeding is a suitable practice in areas where vegetation has been destroyed by cultivation or overgrazing. If this soil was planted to sorghum or small grain the previous year, seeding grass into the stubble helps to protect the seedlings from wind damage. The seed is planted with a drill adapted to grass. Suitable plants for seeding are blue grama, sideoats grama, and western wheatgrass. Installing water facilities, fencing, and using deferred grazing improve or help to maintain the condition of the rangeland. Contour furrowing or pitting can be used in areas where rangeland is in poor or fair condition.

These soils are well suited to homesites and to most urban development. The main limitations for these uses are the moderately slow permeability of the Baca soil and the moderately low strength and moderate shrink-swell potential of both soils. Roads need to be designed to compensate for the limited ability of these soils to support a load. It is good practice to avoid saturating the soil material adjacent to foundations and to install drainageways that direct water from buildings. If septic tank absorption fields are used, an additional absorption line is needed to compensate for the moderately slow permeability. Placing the absorption line below the subsoil is a good practice.

This complex is in capability subclasses IVe, dryland, and IIe, irrigated.

5—Bankard-Glenberg complex. This complex consists of deep, somewhat excessively drained and well drained soils that are nearly level. These soils are on flood plains and terraces. They formed in sandy allvuium. Slope is 0 to 1 percent. The average annual precipitation is about 14 inches.

This complex is about 60 percent the Bankard soil and about 30 percent the Glenberg soil. The Bankard soil is adjacent to the stream channel. The Glenberg soil is around the edges of the map unit.

Included with this complex in mapping are small areas of soils that have a clay loam surface layer and soils that have a seasonal high water table above a depth of 40 inches.

Typically, the Bankard soil has a surface layer of brown loamy fine sand about 4 inches thick. The underlying layer, to a depth of 60 inches or more, is stratified pale brown to dark brown loamy sand that has thin layers of sandy loam. The soil is calcareous below a depth of 4 inches.

The Bankard soil has rapid permeability. Available water capacity is low. Effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 60 inches. Surface runoff is very low, and the hazard of erosion is moderate. The hazard of soil blowing is very high. Eroding away of streambanks is a problem on this soil. This soil is subject to flooding during periods of heavy runoff.

Typically, the Glenberg soil has a surface layer of grayish brown fine sandy loam about 5 inches thick. The underlying layer, to a depth of 60 inches or more, is pale brown sandy loam stratified with thin layers of loamy sand to clay loam. The soil is calcareous throughout.

The Glenberg soil has moderately rapid permeability. Available water capacity is moderate. Effective rooting depth is about 60 inches. Under native vegetation the average annual wetting depth of the soil is about 45 inches. Surface runoff is slow, and the hazard of erosion

is slight. The hazard of soil blowing is very high. This soil is subject to flooding during periods of heavy runoff.

These soils are used as rangeland and are well suited to this use. The native vegetation is mainly tall, deep rooted grasses, such as blue grama, prairie sandreed, needleandthread, and sand sagebrush. In a deteriorated condition, the proportion of dominant deep-rooted grasses, which are the most desirable of the native plants, decreases; the proportion of forbs and sand sagebrush increases. Undesirable perennials and annuals invade as the condition of rangeland becomes poorer. Seeding native grass into an established cover crop is advisable if the rangeland is in poor condition. Desirable plants for seeding are switchgrass, sand bluestem, Indiangrass, and prairie sandreed. If there is no danger that grazing animals will become bloated, yellow blossom or white blossom sweetclover may be added to the seeding mixture to provide a source of nitrogen. Brush control and grazing management help improve deteriorated rangeland. This soil is subject to flooding, so a heavy cover of grass should be maintained to protect it. When a large enough area makes it feasible, fencing the site controls grazing. Grazing animals have a tendency to concentrate in these areas because the grass receives more moisture and stays green longer than adjacent rangeland.

These soils are not suited to dryfarming because of flooding, a very high hazard of erosion, and low or moderate available water capacity.

These soils are poorly suited to homesites and to urban development. The main limitation is flooding. Because of the flooding, these soils are best left open and unrestricted. Seepage could cause septic tank absorption fields to pollute ground water. When excavating this soil, sloughing of banks is a problem. This complex is sometimes used as a source of sand for construction material.

This complex is in capability subclasses VIw, dryland, and IVw, irrigated.

6—Bijou loamy sand, 0 to 2 percent slopes. This deep, somewhat excessively drained soil is nearly level. It is in low lying areas of the sandhills. It formed in noncalcareous, eolian sand. Slopes are typically short and slightly undulating. The average annual precipitation is about 14 inches.

Typically, the surface layer is brown loamy sand about 7 inches thick. The subsoil extends to a depth of 24 inches. It is brown, dark brown, and dark yellowish brown sandy loam. The substratum, to a depth of 60 inches or more, is yellowish brown sand. These soils are noncalcareous above a depth of 40 inches.

Included with this soil in mapping are small areas of Olney and Valent soils. Olney soils differ from the Bijou soil in having more available water capacity. They are in swales. Valent soils are more susceptible to soil blowing and are on small ridges shaped like dunes. These inclusions make up about 10 percent of the mapped area.

The Bijou soil has rapid permeability. Effective rooting depth is 60 inches or more. Where the soil is under native vegetation, the average annual wetting depth is about 45 inches. Available water capacity is low. Surface runoff is very slow. Drainage patterns are poorly defined. The hazard of erosion is slight, but the hazard of soil blowing is very high.

The soil is used mainly for rangeland, but some of the acreage is used for dryfarmed crops. The main dryfarmed crop is grain sorghum, which is grown annually.

This soil has fair suitability for dryfarmed crops. It is extremely difficult to manage as dry cropland because of the very high hazard of soil blowing. The soil is droughty, and establishing a stand is often difficult. Crops often have to be planted a second time to protect them against soil blowing. Leaving stubble is essential to protect the soil from blowing. Row crops should be planted at right angles to the prevailing wind and harvested to leave adequate stubble to protect the soil surface. Excessive grazing of crop residues can leave the soil susceptible to blowing. Tillage pans can form on this soil if it is tilled when wet. Chiseling or subsoiling breaks up pans and improves infiltration of water and penetration of roots; however, chiseling usually does not stop soil blowing. Terraces are normally not recommended.

The most widely accepted method of farming this soil is to plant sorghum in deep listered furrows, fertilize the plants with anhydrous ammonia, and control weeds by using herbicides. If residues are insufficient to keep the soil from blowing, listing deeper into the furrows when planting may be advisable. Anhydrous ammonia needs to be applied when the soil is moist to prevent volatilization. Other farming alternatives are using minimum tillage or no-tillage and planting seed into stubble.

This soil is well suited to rangeland. The native vegetation consists of sand bluestem, prairie sandreed, sideoats grama, little bluestem, sand dropseed, and blue grama. These furnish most of the forage. Sand sagebrush is in scattered stands throughout the vegetation.

The goal of grazing management is to maintain or improve the condition of rangeland by proper grazing. Grazing management should leave a good height of forage standing to protect the soil from blowing and to catch and hold snow. Because soil moisture penetrates deeper into these soils than into hardland soils, maintaining tall, deep-rooted grasses in the stand is important to use the moisture that is at deeper levels. Without management of grazing, the plant cover loses the tall, productive grasses. Deferred grazing is highly effective in management systems for livestock. Placement of livestock watering facilities aids in establishing desired distribution, but animals must not congregate where serious soil blowing can cause blowouts. If heavy grazing is continuous, sand sagebrush or yucca invades and forms a dense stand; brush control becomes needed. Range

seeding is needed in severely depleted areas. This range site can be reseeded with sand bluestem, prairie sandreed, switchgrass, sideoats grama, and little bluestem by using a grass drill capable of handling seed mixed with trash, such as stems, husks and leaves. Seeding grass into cover vegetation is necessary to keep the soil from blowing during seedling establishment. Using equipment that seeds grass into the cover crop with a minimum of disturbance may be desirable to avoid establishing a seed bed.

This soil is well suited to homesites and to most urban uses. Care should be taken to protect the soil from blowing while construction is taking place. When excavating this soil, sloughing of banks can be a problem.

This soil is in capability subclasses IVe, dryland, and IIIe, irrigated.

7—Bijou-Valent loamy sands, 1 to 8 percent slopes. This complex consists of deep, somewhat excessively drained soils that are undulating to gently rolling. These soils are on sandhills (fig. 1). They formed in noncalcareous eolian sand. The average annual precipitation is about 14 inches.

This complex is about 50 percent the Bijou soil and about 40 percent the Valent soil. The Bijou soil is on the smoother parts of the landscape, and Valent soils are on ridges shaped like dunes, which generally lie in a northeastern direction.

Included with this complex in mapping are small areas of Olney and Otero soils. The Olney soils have more available water capacity and are in concave drainage basins. The Otero soils are calcareous throughout and typically are on ridges along the outer edge of the sandhills.

Typically, the Bijou soil has a surface layer of brown loamy sand about 7 inches thick. The subsoil extends to a depth of 24 inches. It is brown, dark brown, and dark yellowish brown sandy loam. The substratum, to a depth of 60 inches or more, is yellowish brown sand. These soils are noncalcareous above a depth of 40 inches.

The Bijou soil has rapid permeability. Effective rooting depth is 60 inches or more. Available water capacity is low. Where the soil is under native vegetation, the average annual wetting depth is about 45 inches. Surface runoff is very slow, so drainage patterns are poorly defined. The hazard of erosion is slight. The hazard of soil blowing is very high.

Typically, the Valent soil has a surface layer of brown loamy sand about 5 inches thick. The underlying layer, which extends to a depth of 60 inches or more, is yel-

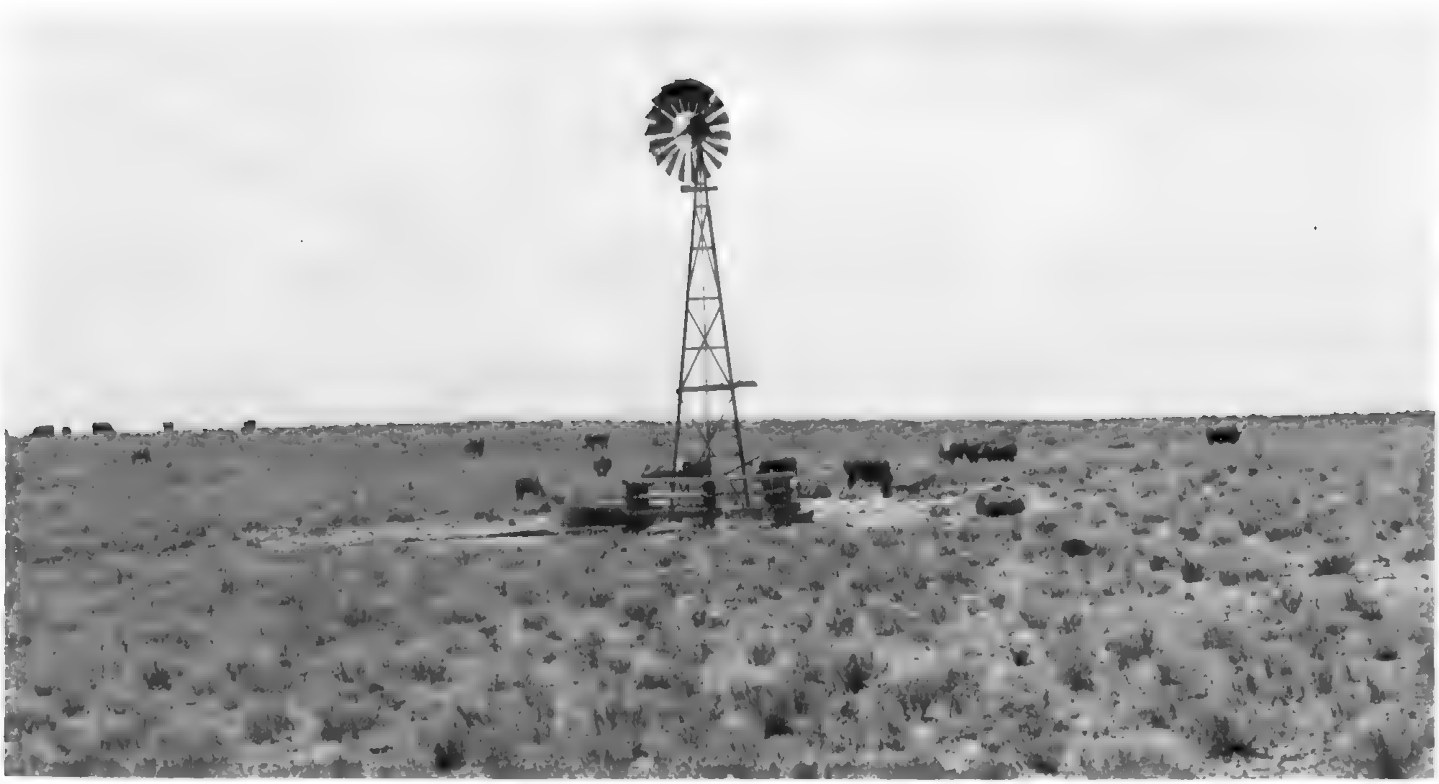


Figure 1.—Area of Bijou-Valent loamy sands, 1 to 8 percent slopes. The sandhills offer abundant vegetation; however, overgrazing has caused deterioration of range productivity. Soil blowing often occurs around water facilities.

lowish brown grading to light yellowish brown sand. The soil is noncalcareous throughout.

The Valent soil has very rapid permeability. Effective rooting depth is about 60 inches or more. Available water capacity is low. Where this soil is under native vegetation, the average annual wetting depth is about 60 inches. Surface runoff is slow. The hazard of erosion is slight. The hazard of soil blowing is very high.

These soils are used for rangeland. A few acres are irrigated by sprinkler.

The main problem of irrigated farming is soil blowing on the ridges. Extreme care should be used to leave adequate residues on the surface to protect against soil blowing. In areas where soil blowing is persistent, incorporating manure into the soil adds organic matter. Because available water capacity is low, applications of irrigation water need to be frequent. Sprinklers should be located where they avoid ridges.

These soils are well suited to rangeland. The native vegetation consists of sand bluestem, prairie sandreed, sideoats grama, little bluestem, sand dropseed, and blue grama. These furnish most of the forage. Sand sagebrush is scattered throughout the vegetation.

The goal of grazing management is to maintain or improve the condition of the rangeland by proper grazing. Grazing management should leave a good height of forage standing to protect the soil from blowing and to catch and hold snow. Because soil moisture penetrates deeper into these soils than into hardland soils, maintaining tall, deep-rooted grasses in the stand is important to use the moisture stored at deeper levels. Without management of grazing, the plant cover loses the tall productive grasses. Deferred grazing is highly effective in management systems for livestock. Placement of livestock watering facilities aids in establishing desired distribution, but animals must not congregate where serious soil blowing can cause blowouts. If heavy grazing is continuous, sand sagebrush or yucca invades and forms a dense stand; brush control becomes needed. Seeding is needed in severely depleted areas. This range site can be reseeded with sand bluestem, prairie sandreed, switchgrass, sideoats grama, and little bluestem by using a grass drill capable of handling seed mixed with trash, such as stems, husks, and leaves. Seeding grass into a cover vegetation is necessary to keep soil from blowing during seedling establishment. Using equipment that seeds grass into the cover crop with a minimum of disturbance may be desirable to avoid establishing a seedbed.

These soils are not suited to dryfarmed crops. The very high hazard of soil blowing and droughtiness make dryfarmed crop production too risky. Farming in the past, later abandoned, has left numerous blowouts and severely eroded areas.

These soils are well suited to homesites and to most urban uses. Special care needs to be taken to control soil blowing during construction. These soils have rapid permeability. Septic tank absorption fields function well; however, a high density of septic systems could pollute shallow wells. Sewage lagoons need to be sealed properly. When excavating in these soils, sloughing of banks is a problem. These soils are sometimes used as a source of sand in construction material.

This complex is in capability subclasses VIe, dryland, and IVe, irrigated.

8—Cadoma clay, 1 to 8 percent slopes. This moderately deep, gently to moderately sloping soil is well drained and saline-alkali-affected. It is on upland plains. It formed in material weathered from shale. Slopes are as much as 1,000 feet long and can be complex. The average annual precipitation is about 13 inches.

Typically, the surface layer is yellowish brown clay about 4 inches thick. The subsoil extends to a depth of 14 inches. The upper 5 inches of the subsoil is yellowish brown clay, and the lower 5 inches is pale brown clay loam. The substratum is light yellowish brown and pale brown, very plastic clay that has common nests of gypsum crystals. Dark gray Pierre Shale is at a depth of 34 inches. The soil is calcareous throughout.

Included with this complex in mapping are small areas of Midway, Limon, and Arvada soils. The Midway soil differs from the other soils in being less than 20 inches deep to shale. It is on ridge crests. Limon is more than 40 inches deep to shale. It is in drainageways. The Arvada soils also are more than 40 inches deep to bedrock and are in swales and drainageways.

Permeability of the Cadoma soil is slow. Effective rooting depth is 20 to 40 inches. Available water capacity is low. Where this soil is under native vegetation, the average annual wetting depth is about 10 inches. Surface runoff is rapid. The hazard of erosion is very high, and the hazard of soil blowing is high.

This soil is used for rangeland. Alkali sacaton forms an almost unbroken stand of grass. Mingled with the dominant grass are blue grama, galleta, fourwing saltbush, and western wheatgrass. As grazing increases and the good stand of alkali sacaton and other more palatable vegetation is destroyed, pricklypear cactus, Fremont goldenweed, two-grooved milkvetch, povertyweed, and inland saltgrass become more dominant.

Because of the high alkalinity, this fragile soil is readily eroded by both wind and water when vegetation is removed. Good grazing management is essential to keep this site in its productive state. Permeability is slow, and the soil can be benefited by pitting and chiseling to increase water storage and reduce runoff. Reestablishing native vegetation by conventional seeding methods is very difficult. The most successful method of reseeding is planting the grass seed by drill in a prepared seedbed, then pitting the area. Pitting should be at a 45 degree angle to the seeding operation. The grasses that are most likely to become established by reseeding are alkali sacaton and western wheatgrass.

This soil is not suited to cultivated crops. Low available water capacity, salinity, and slow permeability make crop production impractical, if not impossible.

These soils are poorly suited to homesites and most urban uses. Depth to shale, slow permeability, high shrink-swell potential, and low strength are limiting soil features. Special engineering designs are needed to construct homes and roads. Septic tank absorption fields do not function properly. Lawns and gardens are difficult to establish and maintain because of the high alkalinity. Building site development is costly. If possible, a more suitable soil should be selected for this use.

This soil is in capability subclass VIe.

9—Canyon-Rock outcrop complex, 1 to 20 percent slopes. This complex consists of the shallow, well drained Canyon soils and limestone Rock outcrop. The Canyon soils are on summits, ridges, and breaks of uplands; the Rock outcrop part is along moderately steep rims. The soil formed in a thin mantle of calcareous, loamy material over limestone and marl. Slopes are short and complex. The average annual precipitation is about 15 inches.

This complex is about 65 percent the Canyon soil and about 20 percent Rock outcrop. The Canyon soil is on nearly level summits and steeper side slopes. The outcrop typically is in a narrow band at the shoulder of breaks.

Included with this complex in mapping are small areas of Kim soils. These deep soils are on foot slopes. Also included are soils that are forming in massive limestone, which is more difficult to excavate, in an area along Big Sandy Creek on the southern county line.

Typically, the Canyon soil has a surface layer of brown, very calcareous gravelly loam about 4 inches thick. The underlying layer is very pale brown grading to white, very strongly calcareous loam. Marl and discontinuous layers of limestone are at a depth of about 19 inches.

Permeability of the Canyon soil is moderate. Available water capacity is very low. Effective rooting depth is less than 20 inches. Where the soil is under native vegetation, the average annual wetting depth is about 12 inches. Surface runoff is rapid, and the hazard of erosion is very high. The hazard of soil blowing is high.

This complex is used for rangeland, and the soils are well suited to this use. The native vegetation is blue grama, little bluestem, and sideoats grama. Threeawn, sand dropseed, and ring muhly increase as the range site deteriorates. It is very important to practice good grazing management to maintain or improve range condition, because this site is very difficult to revegetate. This complex cannot be reseeded or mechanically treated.

These soils are too shallow and too steep to be of value as cropland.

These soils are poorly suited to homesites and most urban uses. The most limiting features are shallow depth to rock, moderately steep slopes, and rock outcrops. These soils are in narrow bands near soil that is better suited to urban development. The material in this complex is sometimes crushed and used as a source of road fill.

This soil is in capability subclass VIIs.

10—Colby silt loam, 1 to 3 percent slopes. This deep, well drained soil is nearly level to gently sloping. It is on rolling upland plains. It formed in loess. Slopes are smooth and generally about 1,000 feet in length. The average annual precipitation ranges from 14 to 16 inches.

Typically, the surface layer is pale brown silt loam about 4 inches thick. The underlying layer, to a depth of 60 inches or more, is very pale brown silt loam. The soil is calcareous throughout.

Included with this soil in mapping are small areas of Wiley soils, which are in the more nearly flat areas in the central and southeastern part of the county. When tilled this soil forms clods that are slightly more stable than those of the Colby soil. Also included is the Norka soil, which is in more nearly flat areas in the eastern part of the county. The Norka soil is less erosive and has higher yields than the Colby soil.

Permeability of this Colby soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Where this soil is under native vegetation, the average annual wetting depth is about 15 inches. Surface runoff is medium, and the hazard of erosion is high. The hazard of soil blowing is high.

This soil is used mainly for dryfarmed crops and rangeland. Wheat is the principal crop grown. Minor amounts of millet and forage sorghum are grown.

This soil is poorly suited to dryfarming. It is on knolls and hillsides, where it is vulnerable to wind and runoff. Soil blowing is the main limitation of this soil. Wind resistant clods are difficult to maintain because of the high amount of lime and the low organic-matter content in the surface layer. The high content of lime can also cause iron chlorosis in sorghum crops.

Because of the erosive nature of this soil, a very high level of management is required to keep the soil from eroding and to maintain its productivity. Maintaining a cover on the surface is essential to protect against soil blowing and to conserve moisture. A minimum of 1,600 pounds of stubble needs to be left on the soil at planting time; however, this amount could be reduced if stripcropping is used. Wind stripcropping or contour stripcropping effectively protects the soil from blowing. If soil blowing persists, additions of manure can be helpful on small knolls. If soil blowing cannot be controlled in larger areas, these soils should be planted to native grass. Farming on the contour and terracing help to control erosion and conserve moisture. In some years, a catch crop may need to be planted for soil protection.

The soil is well suited to rangeland. The native vegetation is that of the short grasses. Blue grama, western wheatgrass, and sideoats grama are the most common plants. If overgrazed, buffalograss replaces blue grama and other grasses. Threeawn and sand dropseed increase on this site when the native plant community is disturbed.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold the snow. Seeding the rangeland speeds the revegetation of areas that have been depleted by heavy grazing, cultivation, or other disturbances. A cover crop needs to be planted a year before the grass is to be seeded. A cover crop of sorghum, millet, sudangrass, or small grain establishes protection from the wind for the new seeding. Primary varieties used for seeding are blue grama, sideoats grama, and western wheatgrass. Contour furrowing or pitting are applicable to areas where rangeland is in poor to fair condition.

This soil is well suited to homesites and most urban uses. The main limitation is moderately low strength. Houses need spread footings to distribute the weight over a large area. Diverting drainage away from buildings prevents saturating the soil around foundations.

This soil is in capability subclasses IVe, dryland, and IIe, irrigated.

11—Colby silt loam, 3 to 9 percent slopes. This deep, well drained soil is moderately sloping and is on rolling, upland plains. It formed in loess. Slopes range from smooth to complex and are usually about 500 feet in length. The average annual precipitation ranges from 14 to 16 inches.

Typically, the surface layer is pale brown silt loam about 4 inches thick. The underlying layer, to a depth of 60 inches or more, is very pale brown silt loam. The soil is calcareous throughout.

Included in this unit are small areas of Wiley soils. Wiley soils form clods. When tilled, these soils are slightly more resistant than the Colby soil. They are on foot slopes.

Permeability of this Colby soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Where this soil is under native vegetation, the average annual wetting depth is about 13 inches. Surface runoff is rapid, and the hazard of erosion is very high. The hazard of soil blowing is high.

This soil is used mainly for rangeland; however, a few acres are in crops.

The native vegetation is that of the short grasses. Blue grama, western wheatgrass, and sideoats grama are the most common plants. If overgrazed, buffalograss replaces blue grama and the other grasses. Threeawn and sand dropseed increase on this site when the potential plant community is disturbed.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Seeding rangeland speeds the revegetation of areas that have been depleted by heavy grazing, cultivation, or other disturbances. A cover crop needs to be planted a year before the grass is to be seeded. A cover crop of sorghum, millet, sudangrass, or small grain establishes protection from the wind for the new seeding. Primary varieties used for seeding are blue grama, sideoats grama, and western wheatgrass. Contour furrowing or pitting are applicable in areas where rangeland is in fair to poor condition.

This soil is unsuited for dryfarmed crops because of the high hazard of erosion.

The soil is well suited to homesites and to most urban uses. The main limitation is moderately low strength. Houses need spread footings to distribute the weight of the building over a large area. Diverting drainage away from buildings prevents saturating the soil around foundations. Structures and landscaping need to be designed to compensate for slope.

This soil is in capability subclasses VIe, dryland, and IIIe, irrigated.

12—Fluvaquents, nearly level. These soils are somewhat poorly drained and poorly drained. They are on flood plains along Rush Creek and Big Sandy Creek, and they are also adjacent to lakes, where seep water has affected the soil. Slopes are 0 to 1 percent. The average annual precipitation is about 14 inches.

The texture, depth to the seasonal high water table, and thickness of the layers vary in these soils. One of the more common profiles has a surface layer of brown clay loam about 5 inches thick. The underlying material, which extends to a depth of 60 inches or more, is mottled, stratified soil material that ranges from gravelly sand to clay.

This unit is extremely variable from place to place. The texture ranges from being dominantly sand to being dominantly clay. Typically, the soil has a higher clay content along Rush Creek and is more sandy along Big Sandy Creek.

Included with these soils in mapping are small areas of moderately well drained soils, which are near the outer edge of the map unit, and very poorly drained soils, which are adjacent to the stream channel.

Fluvaquents, nearly level, have a seasonal high water table that ranges in depth from 1 to 3 feet during the spring; however, in dry years the water table may be deeper. They are subject to frequent flooding during spring and summer, except where they are adjacent to lakes. Surface runoff is slow. The capacity to supply water for plant growth is high.

These soils are used for rangeland and for wildlife habitat and are suited to these uses. Areas of these soils

are in meadow. The soils have a seasonal high water table. Alkali sacaton, saltgrass, switchgrass, western wheatgrass, yellow indiangrass and alkali muhly are the main grasses of the rangeland. If overgrazed by livestock, rushes and sedges replace the switchgrass and other taller grasses. Key forage grasses need to be maintained by proper grazing management, which includes deferring grazing during the growing season at well-timed intervals. These soils can be reseeded to rangeland species or adapted, introduced grasses, such as tall wheatgrass.

Wetland wildlife, especially waterfowl, use these soils. The wetness of these soils allows production of wetland plants that provide nesting and protective cover, as well as some food, for waterfowl.

These soils are unsuited to farming because of wetness, salt content, and flooding.

These soils are poorly suited to homesites and to most urban uses. The principal soil limitations are flooding and wetness. Onsite investigation is necessary to properly evaluate a specific site.

These soils are in capability subclass Vw.

13—Fort Collins sandy loam, 0 to 3 percent slopes. This deep, well drained soil is nearly level to gently sloping. It is on plains and swales of uplands. It formed in calcareous loamy material that is mantled, in places, by a thin layer of eolian, sandy loam material. Slopes are mainly smooth and as much as one-half mile in length. The average annual precipitation ranges from 12 to 15 inches.

Typically, the surface layer is brown sandy loam about 6 inches thick. The subsoil extends to a depth of 26 inches. The upper 8 inches of the subsoil is brown clay loam. The lower 12 inches is pale brown loam. The substratum, to a depth of 60 inches or more, is pale brown loam. The soil is calcareous below a depth of 14 inches.

Included with this soil in mapping are small areas of Kim soils. Kim soils are on knolls and have a light colored surface layer. Also included are areas of soils that have a loam surface layer.

Permeability of the Fort Collins soil is moderate. The available water capacity is high. The effective rooting depth is 60 inches or more. Under native vegetation, the average annual wetting depth of the soil is about 22 inches. Surface runoff is slow, and the erosion hazard is moderate. The hazard of soil blowing is very high.

This soil is used for dryfarmed crops and for rangeland. Dryfarmed crops are mainly wheat, millet, and forage sorghum. Grain sorghum is occasionally grown.

This is one of the better soils for growing wheat in Kiowa County. The soil is well suited to cropland if soil blowing is controlled. Because of the sandy surface layer, this soil efficiently absorbs and stores water; however, it also is susceptible to blowing. Keeping a cover on the soil is essential. Stripcropping, stubble mulch, and maintaining a cloddy surface reduce soil blowing and conserve moisture. A minimum of about 1,600 pounds of residue needs to be left on the surface at planting time, but this amount could be reduced if narrow, wind stripcropping is used. Terraces and contour farming help reduce water erosion and conserve moisture. Tillage pans form easily if this soil is tilled when wet. Chiseling or subsoiling breaks up tillage pans and improves water infiltration and penetration of roots into the soil. Tillage needs to be kept to a minimum. Using chemicals to control weeds could leave the maximum residue on the surface, thereby reducing soil blowing.

The soil is well suited to use as rangeland. The native vegetation on this site is blue grama, which has a typical bunchgrass growth and makes up 1/3 to 1/2 of the cover. Other frequent species are sand dropseed, sideoats grama, western wheatgrass and low rabbitbrush. If the range is in a deteriorated condition, blue grama increases at first, but under continued heavy grazing decreases. Blue grama is replaced by threeawn, pricklypear, undesirable forbs, and annual vegetation. Seeding is advisable if the rangeland is in a deteriorated condition. Primary varieties used for seeding are blue grama, sideoats grama, and little bluestem. If the range is severely eroded and blowouts have developed, fertilizing the new seed is advisable. Most introduced grasses will soon die out. A cover crop needs to be planted a year before the grass is to be seeded to establish wind protection for the new seeding. Using equipment that seeds grass into the cover crop with a minimum of disturbance may be desirable if the potential for serious crop failure exists. Brush control may be needed, and grazing management may help improve the depleted rangeland. Grazing management should leave a good height of forage standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

This soil is in the vicinity of Eads and other towns in Kiowa County; therefore it might be used as building sites either as large scale urbanization or possibly low density areas of single dwellings. This soil is well suited to homesites and to most urban uses. The main limitations are moderate shrink-swell potential, moderate permeability, and low strength. When designing roads, care needs to be taken to overcome the limited ability of the soil to support a load. Septic tanks absorption fields should function properly; however, because of the moderate permeability, additional leach lines are needed. Locating the lateral line below the subsoil is advisable. The moderate shrink-swell potential can be overcome by backfilling with material that has less clay.

This soil is in capability subclasses IVe, dryland, and IIe, irrigated.

14—Goshen silt loam. This deep, well drained soil is nearly level. It is in upland drainageways. It formed in alluvium that washed from loess. Slopes are smooth, except for short, steep slopes that are adjacent to drain-

age channels. Slope is 0 to 1 percent. The average annual precipitation is about 17 inches. Some gullies may be cut into the soil during floods. This soil is subject to flooding during intense rains.

Typically, the surface layer is grayish brown silt loam about 5 inches thick. The subsoil extends to a depth of 36 inches. It is dark grayish brown grading to brown silty clay loam. The substratum, extending to a depth of 60 inches or more, is pale brown silt loam. The soil is calcareous below a depth of 36 inches.

Included with this soil in mapping are small areas of soils that are higher in clay and more slowly permeable than the Goshen soil and have high shrink-swell potential. This inclusion is around intermittent lakes.

Permeability of this Goshen soil is moderate. Effective rooting depth is 60 inches or more. Where this soil is under native vegetation, the average annual wetting depth is about 40 inches. Available water capacity is high. Surface runoff is slow. The hazards of erosion and soil blowing are moderate.

This soil is used mainly for dryfarmed crops. The dryfarmed crops are wheat and millet. A small acreage is rangeland.

This fertile soil is in drainage bottoms. At times, it receives beneficial overflow, and it is somewhat sheltered from high winds. It is well suited to cropping and is one of the most productive soils in Kiowa County.

The main concerns in management are conserving soil moisture and keeping the soil from blowing. Management that controls soil blowing and conserves moisture maintains a cover of plants or stubble at all times, maintains a cloddy surface, and uses minimum tillage and stripcropping. A minimum of 1,300 pounds of stubble needs to be retained on this soil at planting time; however, this amount could be reduced if stripcropping is used. Terraces are normally not used on this soil because of flooding. Diversions may be needed, however, to stop gullies from cutting into the soil. When weeding, only equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. Using this type of equipment and applying a preemergence herbicide or both a contact and preemergence herbicide conserves moisture, controls soil blowing, and keeps tillage to a minimum.

This soil is well suited to rangeland. The native plant community consists of western wheatgrass, blue grama, and buffalograss as the major species. These grasslands are often subject to heavy livestock grazing because of the lushness of the vegetation, the proximity to watering places, and the protection from cold winds that this site provides. If heavily grazed, the taller grasses are replaced by short and midgrasses. Periodic deferment of grazing maintains productivity. Water spreading is highly beneficial on suitable areas of these soils. Water spreading must conform to Colorado water laws. Seeding rangeland is needed in severely depleted areas. This range site can be reseeded with sand bluestem, prairie sandreed, switchgrass, sideoats grama, and little bluestem by using a grass drill capable of handling seed mixed with trash, such as stems, husks, and leaves. Seeding into a cover crop is necessary to keep the soil from blowing during seedling establishment.

This soil is poorly suited to homesites and most urban uses because of flooding. Septic tank absorption fields do not function properly during floods.

This soil is in capability subclasses IIIe, dryland, and IIe, irrigated.

15—Haverson clay loam. This deep, well drained soil is nearly level. It is on flood plains. It formed in calcareous, loamy alluvium. Slopes are dominantly smooth, except for short slopes next to drainage channels. They are about 1,000 feet in length and 0 to 1 percent. The average annual precipitation is about 14 inches.

Typically, the surface layer is grayish brown clay loam about 14 inches thick. The underlying material, to a depth of 60 inches or more, is light brownish gray to brown loam to silty clay loam that is stratified with thin layers of sandy loam. The soil is calcareous throughout.

Included with this soil in mapping are small areas of Limon and Glenberg soils. Limon soils have slow permeability and are in potholes or in backwater areas. Glenberg soils have moderately rapid permeability and are near the stream channel.

Permeability of this Haverson soil is moderately slow. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 22 inches. Surface runoff is slow, and the hazard of erosion is moderate. The hazard of soil blowing is high.

This soil is used for rangeland and dryfarmed crops. A few areas are irrigated. The dominant crop is dryfarmed wheat. Alfalfa maintains itself; however, establishing a stand is difficult. In irrigated areas, corn, grain sorghum, and alfalfa are the dominant crops.

Suitability is fair for dryfarmed crops. The main concerns of management are conserving soil moisture, controlling soil blowing, and controlling water erosion. Proper management includes maintaining a cover of plants or stubble on the soil surface at all times, maintaining a cloddy surface, using minimum tillage, and stripcropping. A minimum of 1,600 pounds of stubble needs to be retained on the surface at planting time; however, this amount could be reduced if stripcropping is used. When weeding, only equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. Tillage should be kept to a minimum. Crops respond to nitrogen fertilizer, but nitrogen should only be added when moisture is adequate.

Eroding away of gully heads and banks can be a problem in some areas. Diversions or dams to control erosion may be needed to stop gullying. This soil is

subject to rare flooding during heavy rains in the spring. Because of the flooding, terracing is normally not recommended on this soil. In periods of heavy rains, the overflow causes damage to crops and crop residues, so the soil is more susceptible to blowing when it drys out. In irrigated areas, the main management concern is applying the proper amount of irrigation water to get the maximum plant growth with the least amount of water.

This soil is well suited to rangeland. The native vegetation consists of western wheatgrass and blue grama as the major species. The grassland is often subject to heavy use by livestock because of the lushness of the vegetation, proximity to watering places, and the protection from cold winds. If heavily grazed, the taller grasses are replaced by short and midgrasses. Periodic deferred grazing is recommended to maintain productivity. Water spreading is highly beneficial on suitable areas of these soils. Water spreading must conform to Colorado water laws. Seeding rangeland is needed in severely depleted areas. This range site can be reseeded with sand bluestem, prairie sandreed, switchgrass, sideoats grama, and little bluestem, by using a grass drill capable of handling seed mixed with trash, such as stems, husks, and leaves. Seeding into a cover crop is necessary to keep the soil from blowing during seedling establishment.

The soil is poorly suited to homesites and to most urban uses because of flooding. Detailed hydrologic studies are needed before locating any structure within this map unit.

This soil is in capability subclasses IVe, dryland, and IIw, irrigated.

16—Haverson clay loam, saline. This deep, well drained soil is nearly level. It is on flood plains. It formed in calcareous, loamy alluvium. Slopes are dominantly smooth, but in some places short, steep slopes are next to the drainage channels. Slope is 0 to 1 percent. The average annual precipitation is about 13 inches. This soil is subject to flooding during heavy rains. Eroding away of gully heads and banks can be a problem in some areas. Diversions or dams to control erosion may be needed to stop gullying.

Typically, the surface layer is grayish brown clay loam about 14 inches thick. The underlying material, which extends to a depth of 60 inches or more, is light brownish gray to brown clay loam that is stratified with thin layers of loam and sandy loam. The soil is slightly saline and calcareous throughout.

Included with this soil in mapping are small areas of Limon and Arvada soils. Limon soils have slow permeability. Arvada soils are alkaline and occur as slick spots.

Permeability of this Haverson soil is moderately slow. Available water capacity is moderate because of excess salts. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 18 inches. Surface runoff is slow, and the hazard of erosion is moderate. The hazard of soil blowing is high.

This soil is used as rangeland and is well suited to this use. The native vegetation is mainly alkali sacaton, galleta, western wheatgrass, and blue grama. If overgrazed, it is replaced by pricklypear, galleta, snakeweed, greasewood, and annuals. Amount and distribution of livestock needs to be controlled to facilitate uniform grazing because of the lushness of some of the vegetation. Reestablishing native grass is very difficult. The most successful method of reseeding is planting the grass seed by drill then pitting the area. The pitting, making shallow pits to hold water, should be at a 45 degree angle to the holes that have been drilled for seed. The grasses that are most likely to become established by reseeding are alkali sacaton and western wheatgrass. Water spreading is highly beneficial in suitable areas of these soils. Water spreading must conform to Colorado water laws.

This soil is not suited to dryfarming because of salinity and a high hazard of soil blowing.

The soil is poorly suited to homesites and to most urban development because of flooding. Detailed hydrologic studies are needed before locating any structure within this map unit.

This soil is in capability subclasses VIe, dryland, and IIIw, irrigated.

17—Keyner loamy sand, 0 to 2 percent slopes. This deep, well drained soil is nearly level. This saline-alkali-affected soil is in low lying areas in the sandhills. It formed in mixed sediment and eolian material. Slopes are smooth to slightly hummocky. The average annual precipitation is about 15 inches.

Typically, the surface layer is brown loamy sand about 11 inches thick. The subsoil extends to a depth of 26 inches. The upper 6 inches of the subsoil is brown sandy clay loam. The lower 9 inches is light yellowish brown sandy loam. The substratum, to a depth of 60 inches, is light yellowish brown sandy loam. The lower part of the subsoil and the substratum has a high content of sodium salts and other salts. The soil is calcareous below a depth of 17 inches.

Included in mapping are small slick spots and Bijou soils. The slick spots are in slightly lower areas. They have a clay loam surface layer that has a high content of sodium salts and other salts. The Bijou soils are on small ridges and are not affected by salt.

Permeability of this Keyner soil is moderately slow. Available water capacity is low because of high salt concentrations. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 35 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

This soil is used entirely as rangeland, and it is well suited to this use. Numerous wells located in this unit

indicate the depth to the seasonal high water table is shallow. The sodium content of the water is high. The native vegetation is dominantly alkali sacaton, blue grama, inland saltgrass, and western wheatgrass. When the range condition deteriorates, the proportion of pricklypear, inland saltgrass, annuals, and other less desirable plants increases. Large bare spots are present where livestock congregate. These spots are highly susceptible to soil blowing. Native grass is very difficult to reestablish because of alkalinity and soil blowing. The best method of seeding the rangeland is to use equipment that seeds grass into the cover crop with a minimum of disturbance. The most suitable grasses for reseeding are alkali sacaton, western wheatgrass, and blue grama. This soil should be managed carefully to avoid excessive blowing.

This soil is not suited to dryfarming because of the high alkalinity and very high hazard of soil blowing.

This soil is well suited to homesites and to most urban development. The main limitations are high salt content and very high hazard of soil blowing. During construction or any soil disturbance, care should be taken to control soil blowing. Lawn grasses and garden vegetables that are salt tolerant need to be selected. It is especially important to locate lateral lines for septic tank absorption fields below the moderately slowly permeable subsoil.

This soil is in capability subclass VIs.

18—Keyner Variant loamy sand. This deep, well drained soil is nearly level. This saline-alkali-affected soil is on terraces of Big Sandy Creek. It formed in sandy eolian and alluvial material over clayey alluvium. Slopes are hummocky and from 0 to 1 percent. The average annual precipitation is about 15 inches. This soil is subject to rare flooding during periods of extremely heavy runoff.

Typically, the surface layer is brown loamy sand about 10 inches thick. The subsoil extends to a depth of 29 inches. The upper 4 inches of the subsoil is yellowish brown sandy loam. The lower 15 inches is olive yellow sandy clay loam grading to clay loam. The substratum extends to a depth of 60 inches or more. The upper 8 inches is olive yellow clay loam. Pale olive clay is at a depth of about 37 inches. The lower part of the subsoil and the substratum has a high content of sodium salts and other salts. The soil is calcareous below a depth of 14 inches. The lower part of the soil is often moistened by the capillary fringe of a seasonal high water table.

Included in mapping are Limon and Keyner soils. The Limon soils have either a clay surface layer or only a few inches of loamy sand over clay. They are on flats or in small depressions. Keyner soils do not have clay in the substratum as does the Keyner Variant. Also included are small slick spots which are strongly alkaline in the surface layer.

Permeability of this Keyner Variant soil is very slow. Available water capacity is low because of high salt concentrations. Effective rooting depth is 60 inches or more. Where the soil is under native vegetation, the average annual wetting depth is about 20 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

The soil is used entirely as rangeland, and it is well suited to this use. Numerous wells located in this unit indicate depth to the seasonal high water table is shallow. The sodium content of the water is high. The native vegetation is dominantly alkali sacaton, blue grama, inland saltgrass, and western wheatgrass. When the range condition deteriorates, the proportion of pricklypear, inland saltgrass, annuals, and other less desirable plants increases. Large bare spots are present where livestock congregate. These spots are highly susceptible to soil blowing. Native grass is very difficult to reestablish because of alkalinity and soil blowing. The best method of seeding rangeland is to use equipment that seeds grass into the cover with a minimum of disturbance. The most suitable grasses for reseeding are alkali sacaton, western wheatgrass, and blue grama. This soil needs to be managed carefully to avoid excessive blowing.

This soil is unsuited to dryfarming because of the high salt content and alkalinity.

This soil is poorly suited to homesites and to most urban uses. The primary limitations are high shrink-swell potential, rare flooding, and very slow permeability. The hazards of development on this soil are so great that a more suitable soil should be selected. The Keyner Variant could be a possible source of adobe.

This soil is in capability subclass VIs.

19—Kim-Canyon complex, 2 to 10 percent slopes. This complex consists of deep and shallow, well drained soils that are undulating to rolling. These soils are on plains and ridges of uplands. Slopes are generally complex and less than 500 feet in length. The average annual precipitation ranges from 12 to 16 inches.

This complex is 65 percent the Kim soil and about 20 percent the Canyon soil. The Kim soil is in areas between ridges. The Canyon soil is on ridges that are typically covered with white pebbles of gravel.

Included with this complex in mapping are small areas of Otero soils and soils that are 20 and 40 inches deep to bedrock. The Otero soil is sandier than the Kim and Canyon soils. They are on side slopes.

The Kim soil is deep. It formed in calcareous, loamy sediment. Typically, the Kim soil has a surface layer of brown loam about 4 inches thick. The underlying layer to a depth of 60 inches or more, is pale brown loam. The soil is calcareous throughout.

Permeability of the Kim soil is moderate. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 15 inches. Surface runoff is medium, and the erosion hazard is high. The hazard of soil blowing is high.

The Canyon soil is shallow. It formed in soil material weathered from limestone and in marl. Typically, the Canyon soil has a surface layer of brown, very calcareous gravelly loam about 4 inches thick. The underlying layer is very pale brown grading to white, very strongly calcareous loam. Marl that has discontinous layers of limestone is at a depth of about 19 inches.

Permeability of the Canyon soil is moderate. The available water capacity is very low. The effective rooting depth is 10 to 20 inches. Under native vegetation the average annual wetting depth of the soil is about 12 inches. Surface runoff is rapid. The hazards of erosion and soil blowing are high.

These soils are used for rangeland. A few acres are used for dryfarmed crops. Wheat is the principal crop grown.

These soils are not suited to dryfarming. The proportion of shallow soils and the high hazard of erosion make cropping difficult.

These soils are well suited to rangeland. The native vegetation consists of blue grama, western wheatgrass, sideoats grama, and little bluestem. These soils cannot support a high density of plants. Ideally, plants grow in clumps, but clumps are spaced closely enough to prevent soil blowing. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase as the condition of rangeland deteriorates. Seeding rangeland may be needed on the Canyon soil. Primary varieties for seeding are blue grama, sideoats grama, and western wheatgrass. Grazing should leave 50 percent, by weight, of the forage standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow.

These soils have fair suitability for homesites and for most urban uses. The Canyon soil is shallow to bedrock. This makes excavating difficult and limits the use of septic tank filter fields. The Kim soil should be selected for building sites.

This complex is in capability subclass VIe.

20—Kim-Harvey loams, 1 to 3 percent slopes. This complex consists of deep, well drained soils that are nearly level to gently sloping. These soils are on plains and side slopes of uplands. These soils formed in calcareous loamy material. Slopes are generally about 500 feet in length. The average annual precipitation ranges from 12 to 16 inches.

This complex is about 50 percent the Kim soil and about 35 percent the Harvey soil. These soils are on the same landscape.

Included with this complex in mapping are small areas of Stoneham soils. Stoneham soils are slightly less erosive than the Kim and Harvey soils. They are on more nearly flat areas.

Typically, the Kim soil has a surface layer of pale brown loam about 4 inches thick. The underlying material, to a depth of 60 inches or more, is very pale brown loam. The soil is calcareous throughout.

Permeability of the Kim soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is high. Where the soil is under native vegetation, the average annual wetting depth is about 13 inches. Surface runoff is medium. The hazards of erosion and soil blowing are high.

Typically, the Harvey soil has a surface layer of pale brown loam about 5 inches thick. The subsoil is light yellowish brown clay loam about 13 inches thick. The substratum to a depth of 50 inches is white loam and light yellowish brown sandy clay loam. Below this, to a depth of 60 inches or more, is light yellowish brown gravelly sandy loam. The soil is calcareous throughout. The carbonate content in the underlying soil material is great enough to adversely affect crop growth.

Permeability of the Harvey soil is moderate. Effective rooting depth is 60 inches or more. Available water capacity is moderate. Where this soil is under native vegetation, the average annual wetting depth is about 13 inches. Surface runoff is medium. The hazards of erosion and soil blowing are high.

These soils are used mainly for rangeland. Some acreage is used for dryfarmed crops. Wheat is the dominant crop.

Dryland production on these soils are marginal. In most years, young crops are difficult to establish. Seedling mortality is high, and crops often suffer from moisture stress. Because of the high content of lime, wheat and especially sorghums develop iron chlorosis. Because these factors decrease the amount of plant cover, the rate of erosion increases. For these reasons, this map unit should not be used for nonirrigated cropland.

These soils are well suited to rangeland. The dominant native grasses are blue grama and sand dropseed. They make up nearly two-thirds of the vegetative cover. These two grasses combine with western wheatgrass and sideoats grama. These soils cannot support a high density of plants because of the limited rainfall. Usable forage tends to be reduced. Ideally, plants grow in clumps, but clumps are spaced closely enough to prevent soil blowing. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase as range condition deteriorates. Western wheatgrass and sideoats grama decrease under mismanagement.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Seeding rangeland speeds the revegetation of areas depleted by heavy grazing, cultivation, or other disturbances. A cover crop of sorghum, millet, sudangrass, or small grain should be planted a year before the grass is to be seeded. Primary varieties of grass seeds are blue grama, sideoats grama, and western wheat-

grass. Contour furrowing or pitting are applicable where rangeland is in poor and fair condition.

These soils are well suited to homesites and to most urban uses. The main limitations are moderately low strength, moderate shrink-swell potential, and moderate permeability. Septic tank absorption fields should have additional leach lines to overcome moderate permeability. Exposing the underlying layer of the Harvey soil should be avoided. The highly calcareous soil material makes the establishment and maintenance of lawns and gardens difficult.

This complex is in capability subclasses VIe, dryland, and IIIe, irrigated.

21—Kim-Harvey-Stoneham loams, 1 to 3 percent slopes. This complex consists of deep, well drained soils that are nearly level to gently sloping. These soils are on plains and side slopes of uplands. They formed in calcareous, loamy material. Slopes are generally about 500 feet in length. The average annual precipitation ranges from 12 to 16 inches.

This complex is about 40 percent the Kim soil, about 25 percent the Harvey soil, and about 25 percent the Stoneham soil. The Kim and Harvey soils are on convex hillsides and knolls, and the Stoneham soil is on more nearly flat parts of the landscape.

Included with this complex in mapping are areas of a soil that has a sandy loam surface layer. The soil occurs on ridges and hillsides, and is more susceptible to blowing than the loams. This inclusion can make up as much as 25 percent of a mapped area.

Typically, the Kim soil has a surface layer of pale brown loam about 4 inches thick. The underlying layer, to a depth of 60 inches or more, is very pale brown loam. The soil is calcareous throughout.

The Kim soil has moderate permeability. The available water capacity is high. The effective rooting depth is about 60 inches. If the soil is under native vegetation, the average annual wetting depth is about 14 inches. Surface runoff is medium, and the hazard of erosion is high. The hazard of soil blowing is high.

Typically, the Harvey soil has a surface layer of pale brown loam about 5 inches thick. The subsoil is light yellowish brown clay loam. It extends to a depth of 18 inches. The substratum, to a depth of 50 inches, is white loam and light yellowish brown sandy clay loam. Below this, to a depth of 60 inches or more, is light yellowish brown gravelly sandy loam. The soil is calcareous throughout. The carbonate content in the substratum is great enough to adversely affect crop growth.

The Harvey soil has moderate permeability. The available water capacity is high. The effective rooting depth is about 60 inches. If the soil is under native vegetation, the average annual wetting depth is about 14 inches. Surface runoff is medium. The hazards of erosion and soil blowing are high.

Typically, the Stoneham soil has a surface layer of brown loam about 4 inches thick. The subsoil extends to a depth of 13 inches. It is brown clay loam grading to pale brown clay loam. The substratum, to a depth of 60 inches or more, is pale brown, light yellowish brown, and very pale brown loam. In cropped areas the soil is typically calcareous throughout.

The Stoneham soil has moderate permeability. The available water capacity is high. The effective rooting depth is about 60 inches. If the soil is under native vegetation, the average annual wetting depth is about 16 inches. Surface runoff is medium. The hazard of erosion is moderate, and the hazard of soil blowing is high.

These soils are used for dryfarmed crops and rangeland. The main crop is wheat, but millet and forage sorghum are also grown.

These soils are poorly suited to farming compared with other soils in Kiowa County. They are on knolls and hillsides where they are vulnerable to wind and rapid runoff. Soil blowing is the main limitation on these soils. Wind resistant clods are difficult to maintain because of the high amount of lime in the surface layer. The high content of lime can also cause iron chlorosis in sorghum crops.

Because of the erosive nature of this soil, a very high level of management is required to keep the soil from eroding and to maintain its productivity. Maintaining a cover crop is essential to protect against soil blowing and to conserve moisture. A minimum of 1,600 pounds of stubble needs to be left on the soil at planting time; however, this amount could be reduced if stripcropping is used. Contour farming and terracing help to control erosion and conserve moisture. Wind stripcropping or contour stripcropping effectively protects the soil from blowing. If soil blowing persists, additions of manure can help on small knolls. If soil blowing cannot be stopped in larger areas, these soils need to be planted back to native grass. In some years, a catch crop may need to be planted for soil protection.

These soils are well suited to rangeland. The native vegetation is mainly blue grama, western wheatgrass, and sand dropseed, which make up nearly two-thirds of the vegetative cover. These grasses combine with sideoats grama. These soils cannot support a high density of plants because of the limited rainfall. Usable forage tends to be reduced. Ideally, plants grow in clumps, but clumps are spaced closely enough to prevent soil blowing. Western wheatgrass and sideoats grama decrease under mismanagement. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase with deterioration of the range condition.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow. Range seeding speeds the revegetation of areas that have been depleted by heavy grazing, cultivation, or

other disturbances. Primary varieties used for seeding are blue grama, sideoats grama, and western wheatgrass. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before the grass is to be seeded to establish wind protection for the new seeding. Contour furrowing or pitting are applicable to areas where rangeland is in poor and fair condition.

These soils are well suited to homesites and most urban uses. The main limitations are moderate shrink-swell potential and moderate permeability. Septic tank absorption fields need an additional leach line to overcome moderate permeability. Exposure of the substratum of the Harvey soil should be avoided. The highly calcareous material would make the establishment and maintenance of lawns and gardens difficult.

This complex is in capability subclasses IVe, dryland, and IIIe, irrigated.

22—Kim-Stoneham-Larimer loams, 3 to 12 percent slopes. This complex consists of deep, well drained soils that are gently to strongly sloping. These soils are on hillsides and ridges, generally adjacent to drainageways. The Kim and Stoneham soils formed in calcareous, loamy material. The Larimer soil formed in mixed material, which overlies sand and gravel. Slopes are complex and typically are less than 500 feet in length. The average annual precipitation ranges from 12 to 16 inches.

This complex is about 35 percent the Kim soil, about 30 percent the Stoneham soil, and about 25 percent the Larimer soil. The Kim soil is on hillsides and ridges. Stoneham soil is in the smoother areas, and the Larimer soil is on hillsides, where sand and gravel lie near the surface.

Included with this complex in mapping are small areas of Vona, Haverson, and Pultney soils. Vona soils are around the rims of knolls. They have moderately rapid permeability. Haverson soils are in drainageways that are flooded during heavy rains, and Pultney soils are on hillsides. The Pultney soils are 20 to 40 inches deep to shale.

Typically, the Kim soil has a surface layer of brown loam about 4 inches thick. The underlying layer, to a depth of 60 inches or more, is yellowish brown loam grading to light yellowish brown sandy clay loam and sandy loam. The soil is calcareous throughout.

The Kim soil has moderate permeability. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 12 inches. Surface runoff is rapid, and the erosion hazard is very high. The hazard of soil blowing is high.

Typically, the Stoneham soil has a surface layer of brown loam about 4 inches thick. The subsoil extends to a depth of 13 inches. It is brown clay loam grading to pale brown clay loam. The substratum, to a depth of 60 inches or more, is pale brown, light yellowish brown, and very pale brown loam. The soil is calcareous below a depth of about 8 inches.

The Stoneham soil has moderate permeability. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 14 inches. Surface runoff is rapid, and the erosion hazard is high. The soil blowing hazard is high.

Typically, the Larimer soil has a layer of grayish brown loam about 3 inches thick. The subsoil extends to a depth of 8 inches. It is dark yellowish brown loam grading to yellowish brown loam. The substratum, to a depth of 28 inches, is pale brown sandy clay loam. Below this, to a depth of 60 inches or more, is brownish yellow very gravelly loamy sand. The soil is calcareous below a depth of about 9 inches.

The Larimer soil has moderate permeability above the gravel and very rapid permeability within the gravel. The available water capacity is moderate. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 12 inches. Surface runoff is rapid. The hazard of erosion and soil blowing are high.

These soils are well suited to rangeland.

The native vegetation is mainly blue grama and western wheatgrass, which make up nearly two-thirds of the vegetative cover. These two grasses combine with western wheatgrass and sideoats grama. These soils cannot support a high density of plants because of the limited rainfall. Usable forage tends to be reduced. Ideally, plants grow in clumps, but clumps are spaced close enough to prevent soil blowing. Western wheatgrass and sideoats grama decrease under mismanagement. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase with deterioration of the rangeland condition.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage is left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Range seeding speeds the revegetation of areas depleted by heavy grazing, cultivation, or other disturbances. Primary varieties used for seeding are blue grama, sideoats grama, and western wheatgrass. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before the grass is to be seeded to establish protection from the wind for the new seeding. Contour furrowing or pitting is applicable in areas where rangeland is in poor and fair condition.

These soils are not suited to dryfarming because of high hazards of erosion and soil blowing.

These soils have fair suitability to homesites and most urban uses. The main limitations are slope, moderate shrink-swell potential, and moderate permeability. Septic tank absorption fields need to have additional leach lines to overcome the moderate permeability of the Kim and Stoneham soils. Sloughing of excavation banks is a con-

cern in the Larimer soil, which is often used as a source of road fill.

These soils are in capability subclasses VIe, dryland, and IVe, irrigated.

23—Limon clay. This deep, well drained soil is nearly level. It is in drainageways and on flood plains along Mustang, Adobe, and Rush Creeks. It formed in clayey alluvium derived from shale. Slopes are uniform and are commonly more than 1,000 feet long. Slope is 0 to 1 percent. The average annual precipitation ranges from 12 to 15 inches. This soil is subject to occasional flooding during heavy rains in spring and summer. Gulley erosion is a concern on this soil, but it can be controlled by dams and diversions.

Typically, the surface layer is brown clay about 6 inches thick. The underlying material, to a depth of 60 inches, is brown clay and clay loam. The soil is calcareous throughout and is nonsaline to slightly saline.

Permeability is slow. Available water capacity is moderate. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 20 inches. Surface runoff is slow, and the hazard of erosion is moderate. The hazard of soil blowing is high.

Included with this soil in mapping are small areas of Arvada soils. The Arvada soil occurs as slick spots. It has a surface layer that has a high content of sodium salts and other salts.

This soil is used for rangeland and is well suited to this use. At times it receives additional water from adjacent uplands, which increases forage production. The native vegetation is mainly alkali sacaton, blue grama, and western wheatgrass. When the range deteriorates, the proportion of pricklypear, snakeweed, annuals, and other less desirable plants increases. The intensity of grazing and distribution of livestock needs to be controlled so growth of the vegetation is uniform. Native grass is very difficult to reestablish on this soil. The most successful method of reseeding grass is to plant the seed by drilling, then pitting the area. The pitting, making shallow pits to hold water, should be done at a 45 degree angle to the holes that have been drilled for seed. The most suitable grasses for reseeding are alkali sacaton and western wheatgrass. Diversions that help to spread the runoff water are highly beneficial to the vegetation.

This soil is not suited to dryfarmed crops because of slow permeability and the hazard of erosion.

This soil is poorly suited to homesite development and to most urban uses. The main limitations for these uses are flooding, high shrink-swell potential, slow permeability, and low strength. Septic tank absorption fields do not function properly because of slow permeability and flooding.

This soil is in capability subclasses VIs, dryland, and IIIs, irrigated.

24—Manzanola clay loam, 0 to 2 percent slopes. This deep, well drained soil is nearly level. It is in upland swales and on flats. It formed in calcareous, clayey alluvium. Slopes are dominantly uniform and about 1,000 feet in length. The average annual precipitation ranges from 12 to 15 inches. Lower lying areas of this map unit are subject to flooding during heavy rains. In some areas as much as 40 percent of the area may be flooded.

Typically, the surface layer is light brownish gray clay loam about 6 inches thick. The subsoil extends to a depth of 32 inches. It is pale brown clay loam grading to light yellowish clay and clay loam. The substratum, to a depth of 60 inches or more, is light yellowish brown clay loam. The soil is calcareous throughout.

Included with this soil in mapping are small areas of Absted and Stoneham soils and Manzanola soils that are flooded. Absted soils are alkali-affected. They are in small depressions. The moderately permeable Stoneham soils are on slightly higher parts of the landscape.

Permeability of this Manzanola soil is slow. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 20 inches. Surface runoff is slow and the hazard of erosion is moderate. The hazard of soil blowing is high.

The soil is used for rangeland and for dryfarmed crops. Wheat is the dominant crop; however, minor amounts of forage sorghum and millet are grown.

This soil is poorly suited to dryfarmed crops when compared to other soils in Kiowa County. The Manzanola soil has a high content of clay. When all vegetation is removed during fallow, the surface layer hardens and becomes difficult to till. Farmers usually refer to a soil in this condition as adobe. Adobe causes plants to suffer from moisture stress, because water does not penetrate the soil surface. The lower layers of this soil have a higher clay content and have excess salts, which are harmful to plants. When these layers are exposed by erosion, this soil is very difficult to manage and is best planted back to grass.

In managing this soil, a cover must be maintained on it to conserve moisture and to protect against soil blowing. A good stubble mulch also helps prevent the sun from baking the soil. A minimum of 1,600 pounds of stubble needs to be left on the soil at planting time; however, this amount could be reduced if stripcropping were used. Wind stripcropping and contour stripcropping are beneficial in reducing soil blowing. Tillage needs to be kept to a minimum to keep the maximum amount of residue on the surface and to keep the soil from packing. The use of herbicides to control weeds could reduce tillage.

Deep chiseling breaks up tillage pans and improves water infiltration. Areas of this soil receive water from adjacent uplands. In most places, this water is shallow and may be beneficial to crops; however, water accumulates in drainageways and washes away crops or crop residues and destroys terraces. After heavy rains, a layer

of silt is often deposited in drainage channels. This newly deposited material is very susceptible to blowing.

This site is well suited to rangeland. The native vegetation consists of alkali sacaton, fourwing saltbush, western wheatgrass, and blue grama. If overgrazed, these plants are replaced by pricklypear, galleta, snakeweed, greasewood, and annuals. Because of the lushness of some of the vegetation, the amount and distribution of livestock is controlled to maintain uniform grazing. This site is very difficult to reestablish to native grass. The most successful method of reseeding is planting grass by drill, then pitting the area. The pitting, making shallow pits to hold water, should be done at a 45 degree angle to the holes that have been drilled for seed. The grasses that are most likely to become established by reseeding are alkali sacaton and western wheatgrass. Water spreading is highly beneficial on suitable areas of these soils. Water spreading must conform to Colorado water laws.

The soil is poorly suited to homesites and to most urban uses. The principal limitations are slow permeability and high shrinking and swelling of the soil. Special sewage systems must be designed. Septic tank absorption fields do not function properly because of slow permeability. Buildings and roads must be designed to compensate for the shrinking and swelling of the soil. Low lying areas of this soil are subject to flooding during heavy rains. Installing embankments or elevating buildings above the water level may be needed to protect homesites, sewage lagoons, and roads from flooding. Special types of concrete are needed on this soil because of the high concentration of sulphates in lower layers. Drainageways should direct water away from buildings.

This soil is in capability subclasses IVe, dryland, and IIe, irrigated.

25—Midway clay, 5 to 12 percent slopes. This shallow, well drained soil is moderately sloping to strongly sloping. It is on upland plains. It formed in calcareous, gypsiferous clayey material derived from shale. Slopes are dominantly complex and about 200 feet in length. The average annual precipitation is about 13 inches.

Typically, the surface layer is light yellowish brown clay about 5 inches thick. The underlying material, to a depth of about 10 inches, is light yellowish brown clay. Below this is soft gray shale. The soil has a high content of salts and is calcareous throughout.

Included with this soil in mapping are small areas of Cadoma and Limon soils. Cadoma soils have shale at a depth of 20 to 40 inches and are on hillsides. Limon soils are deep and in drainageways that are flooded.

Permeability of this Midway soil is slow. Available water capacity is very low. Effective rooting depth is less than 20 inches. Where the soil is under native vegetation, the average annual wetting depth is about 9 inches. Surface runoff is rapid. The hazard of erosion is very high, and the hazard of soil blowing is high.

The soil is used for rangeland. The native vegetation is alkali sacaton, blue grama, and galleta. Sideoats grama is in some areas. As the range site deteriorates, pricklypear, Fremont goldenweed, pullup muhly, and greasewood increase; the density of the vegetation thins; and excessive erosion and soil blowing begin to take place. The presence of princess plume, two-grooved milkvetch, and Fremont goldenweed are indicators of selennium bearing plants.

The goal of good grazing management is to maintain or improve range condition. Reestablishing the native plant community by conventional seeding methods is very difficult on this site because of low infiltration rates, which are caused by very fine-textured, saline soils, and because of the unstable soil condition. Mechanical treatment of the soil by pitting or chiseling increases intake of water into the soil and slows runoff. The most successful method of reseeding grass is to plant the grass by drill in a prepared seedbed, then pit the area. Pitting, making shallow pits to hold water, should be done at a 45 degree angle to the holes that have been drilled for seed. The grasses that are most likely to become established by reseeding are alkali sacaton and western wheatgrass.

This soil is not suited to cultivated crops. The shallow depth to shale and the high salt content limit available water capacity and crop production becomes difficult, if not impossible.

This soil is poorly suited to homesites and to most urban uses. The main limitations are shallow depth to rock, high shrink-swell potential, and slow permeability. Because of the shallow depth to shale, septic tank absorption fields are difficult to excavate and they fail. Steep slopes increase the limitations caused by shallow depth to rock. Specially designed foundations and roads are needed to compensate for shrinking and swelling of the soil. Establishment of lawns and gardens is difficult. Special types of concrete are needed in this soil because of the high sulphate content. Because urban development on this soil can be costly, a more suitable soil should be selected.

This soil is in capability subclass VIIs.

26—Norka silt loam, 0 to 2 percent slopes. This deep, well drained soil is nearly level. It is on flats and smooth hillsides of uplands. It formed in loess. Slopes are dominantly smooth and are as much as one-half mile long. The average annual precipitation is about 16 inches.

Typically, the surface layer is dark brown silt loam about 7 inches thick. The subsoil extends to a depth of 18 inches. It is brown to pale brown silty clay loam. The substratum, to a depth of 60 inches, is very pale brown silt loam. The soil is calcareous below a depth of 11 inches.

Included with this soil in mapping are small areas of Wiley and Richfield soils. The Wiley soils have a light colored surface layer and are more susceptible to soil blowing than this Norka soil. They commonly are at the crests of ridges. Richfield soils have slower permeability than this Norka soil and are in swales.

Permeability of this Norka soil is moderately slow. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 22 inches. Surface runoff is slow, and the hazard of erosion is moderate. The hazard of soil blowing is moderate.

This soil is used mainly for dryfarmed crops. A small acreage is in irrigated crops or is rangeland. The main dryfarmed crops are wheat, millet, and some forage sorghum.

If this soil is dryfarmed, the main concerns in management are to conserve soil moisture and to control soil blowing. Management that controls soil blowing and conserves moisture includes maintaining a cover of plants or stubble at all times, maintaining a cloddy surface, and using minimum tillage, terracing, and stripcropping. During periods of drought, 2 years of fallow may be needed to store enough water in the soil to insure crop production. A minimum of 1,300 pounds of stubble needs to be retained on the surface at planting time. When weeding, only equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. This can be done in the fall and a preemergence herbicide or a contact herbicide can be used to weed. Crops respond to nitrogen fertilizer, but nitrogen should only be added when adequate moisture is available.

This soil is well suited to rangeland. The native vegetation is mainly blue grama, western wheatgrass, and buffalograss. When the rangeland deteriorates, the proportion of buffalograss, sand dropseed, threeawn, and other less desirable plants increases.

Grazing management should leave 50 percent of the forage standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Reseeding is a suitable practice where the vegetation has been destroyed by cultivation or overgrazing. Seeding into stubble of sorghum or small grain planted the previous year helps to protect the seedlings from wind damage. Seed should be planted by a drill adapted to grass. Suitable plants for seeding are blue grama, sideoats grama, and western wheatgrass. Contour furrowing or pitting can be used in areas where rangeland is in poor or fair condition.

This soil is well suited to homesites and to most urban uses. The main limitations for these uses are moderately low strength and moderately slow permeability. Roads and foundations should be designed to compensate for the limited ability of the soil to support a load. Foundations need spread footings to support the weight of the buildings. Saturation of the soil material around buildings could cause foundations to fail; therefore, drainage should lead away from buildings. Septic tank absorption fields generally function properly, but an additional leach line is needed to compensate for the moderately slow permeability.

This soil is in capability subclasses IIIe, dryland, and IIe, irrigated.

27—Olney loamy sand, 0 to 2 percent slopes. This deep, well drained soil is nearly level. It is low lying in the sandhills. It formed in sandy eolian and alluvial material. Areas of this map unit are small and irregularly shaped. Slopes are dominantly smooth and are about 1,000 feet in length. The average annual precipitation is about 15 inches.

Typically, the surface layer is brown loamy sand about 6 inches thick, but may range to 12 inches thick. The subsoil extends to a depth of 27 inches. It is yellowish brown sandy clay loam grading to pale brown sandy loam. The substratum, to a depth of 60 inches or more, is pale brown fine sandy loam. The soil is calcareous below a depth of 19 inches.

Included with this soil in mapping are small areas of Bijou and Sundance soils. Bijou soils have rapid permeability and are in slightly higher parts of the landscape. Sundance soils are over loamy soil material.

Permeability of this Olney soil is moderate. Available water capacity is moderate. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 40 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

This soil is used for dryfarmed crops and for rangeland. Grain sorghum, which is grown annually, is the main crop.

The soil is well suited to crops if soil blowing is controlled. Because of the very high hazard of blowing, this soil is difficult to manage as dry cropland. Leaving stubble standing and stubble mulching is essential to protect the soil from blowing. Row crops should be planted at right angles to the prevailing wind to protect the soil surface. Excessive grazing of crop residues leaves the soil in condition to blow. Tillage pans can form on this soil if tilled when wet. Chiseling or subsoiling breaks up pans and improves infiltration of water and penetration of roots into the soil. Terraces are normally not recommended.

The most widely accepted method of farming this soil is to plant sorghum in deep furrows by lister, to fertilize the plantings with anyhydrous ammonia, and to control weeds by using herbicides. Anhydrous ammonia should be applied when the soil is moist to help prevent volatilization. If residue is insufficient to keep the soil from blowing, deep listing may be advisable. Other farming alternatives are using minimum tillage, no-tillage, and planting in standing stubble. Chiseling to stop soil blow-

ing is generally not effective. The Olney soil is often surrounded by soils that are unsuited for farming because of high hazard of soil blowing. These surrounding soils should be avoided when farming or should be planted to grass.

The soil is well suited to rangeland. Native vegetation is a mixture of tall, mid, and short grasses. Grasses, such as blue grama and sideoats grama, are dominant. Prairie sandreed is the most important tall grass. Plants that are most likely to increase when the rangeland deteriorates are western ragweed, sand sagebrush, prickly poppy, kochia, Russian-thistle, and sunflower. Seeding is advisable if the rangeland is in a deteriorated condition. Primary varieties for seeding are native grasses, such as sand bluestem, sideoats grama, little bluestem, sandreed, switchgrass, and yellow indiangrass. If the soil is severely eroded and blowouts have developed, fertilizing the new seeding is advisable. Other native grasses can be seeded, if seed is available. Introduced grasses soon die out. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before the grass is to be seeded to establish protection from the wind for the new seeding. Using equipment that seeds grass into the cover with a minimum of disturbance may be desirable if the potential for serious crop failure exists. Brush control may be needed. Proper grazing management may help improve the depleted range. Grazing management should leave a good height of forage standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

This soil is well suited to houses and to other urban uses. Care needs to be taken to avoid soil blowing during construction. Sewage lagoons need to be sealed.

This soil is in capability subclasses IVe, dryland, and IIIe, irrigated.

28—Otero sandy loam, 1 to 5 percent slopes. This deep, well drained soil is gently sloping. It is on knolls shaped like dunes and hillsides. It formed in calcareous, medium textured, eolian material. Slopes are dominantly complex and about 100 feet in length. The average annual precipitation is about 13 inches.

Typically, the surface layer is pale brown sandy loam about 2 inches thick. The subsoil is dark yellowish brown sandy loam about 2 inches thick. The substratum, to a depth of 60 inches or more, is light yellowish brown grading to very pale brown sandy loam. The soil is calcareous throughout. These soils were originally Vona soils. Because the noncalcareous upper part of the Vona soil had been removed by erosion, this soil was classified as the calcareous Otero soil.

Included with this soil in mapping are small areas of Kim and Vona soils. Kim soils have moderate permeability and are loamy. Vona soils are slightly less erosive. They are on more nearly flat parts of the landscape.

Permeability of this Otero soil is rapid. Available water capacity is moderate. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 22 inches. Surface runoff is slow. The hazard of erosion is moderate, but the hazard of soil blowing is very high.

The soil is used for dryfarmed crops. Many areas have been planted to grass for use as rangeland.

This soil is not suited to dryfarming. The soil has limited water holding capacity and is droughty. Past farming has allowed the soil to be eroded to the extent that conventional farming cannot control soil blowing. Areas of this soil that are farmed are best planted to grass.

The soil is well suited to rangeland. The native vegetation is blue grama, which typically grows in bunches, and is 1/3 to 1/2 of the cover. Other species that are frequent are sand dropseed and sideoats grama. If the rangeland deteriorates, blue grama increases at first, but under continued heavy grazing it decreases. It is replaced by threeawn, pricklypear cactus, undesirable forbs, and annual vegetation. Seeding to native grasses, such as blue grama, sideoats grama, and little bluestem, is advisable if the rangeland is in a deteriorated condition. If the soil is severely eroded and blowouts have developed, the new seeding needs to be fertilized. Introduced grasses soon die out. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before the grass is to be seeded to establish protection from the wind for the new seeding. Using equipment that seeds grass into the cover crop with a minimum of disturbance may be desirable if the potential for serious crop failure exists. Also, brush control may be needed. Proper grazing management may help improve the depleted rangeland. Grazing management should leave a good height of forage standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

If erosion is controlled, this soil is well suited to homesites and most urban uses. The soil limitations are easily overcome. Sewage lagoons may need to be sealed.

This soil is in capability subclasses VIe, dryland, and IIIe, irrigated.

29—Playas. Playas in this survey area consist of flat, undrained basins. These basins contain shallow water for short periods and at infrequent intervals (*5*). They are usually barren or may be vegetated by annuals. The soil material is usually heavy clay and may have mottling, which indicates poor drainage. These areas are poorly suited to most uses because of ponding; however, they are used as sources of water for livestock and wildlife, and especially by waterfowl.

30—Richfield silt loam, 0 to 1 percent slopes. This deep, well drained soil is nearly level. It is on flats and in depressions of uplands. It formed in loess. Slopes are dominantly uniform and about one-half mile in length. The average annual precipitation is about 17 inches.

Typically, the surface layer is brown silt loam about 7 inches thick. The subsoil extends to a depth of 22

inches. It is brown grading to yellowish brown and pale brown silty clay loam. The substratum, to a depth of 60 inches or more, is very pale brown silt loam. The soil is calcareous below a depth of 18 inches.

Included with this soil in mapping are small areas of Goshen soils. Goshen soils are in drainageways that overflow during heavy rains.

Permeability of this Richfield soil is moderately slow. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 30 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is moderate.

This soil is used for dryfarmed crops. A few areas are used for rangeland. The dominant crops are wheat, millet, and grain sorghum.

This fertile soil is on flats where it is somewhat sheltered from high winds. It is well suited to farming and is one of the most productive soils in Kiowa County. The main concerns in management are conserving soil moisture and keeping the soil from blowing. Management to control soil blowing and to conserve moisture includes maintaining a cover of plants or stubble at all times, maintaining a cloddy surface, using minimum tillage, and stripcropping. A minimum of 1,300 pounds of stubble needs to be retained on this soil at planting time; however, this amount could be reduced if stripcropping is used. Terraces may be used to conserve soil moisture and control water erosion. In moist years terrace channels may be annually cropped. When weeding, equipment that cuts plant roots under the surface and a preemergence herbicide or a contact and preemergence herbicide can be used to conserve moisture, control soil blowing, and keep tillage to a minimum.

The soil is well suited to rangeland. The native vegetation is short grasses. Blue grama is the dominant vegetation. Western wheatgrass and buffalograss are the most common plants associated with the potential plant community. Buffalograss replaces blue grama and western wheatgrass if rangeland is overgrazed. Threeawn and sand dropseed increase on this site when the potential plant community is disturbed.

Proper grazing is the foremost need in range management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Range seeding speeds the revegetation of areas that have been depleted by heavy grazing, cultivation, or other disturbances. Primary varieties used for seeding are blue grama, sideoats grama, and western wheatgrass. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before seeding to establish protection from the wind for the new seeding. Contour furrowing or pitting are applicable in areas where rangeland is in poor and fair condition.

Suitability is fair for homesites and most other urban uses. The main limitations of the soil are high shrink-swell potential and moderately slow permeability of the subsoil. These limitations can be minimized by placing foundations and septic tank absorption fields below the subsoil and backfilling with more suitable soil material. Also, septic tank absorption fields need to be lengthened to compensate for moderately slow permeability.

This soil is in capability subclasses IIIe, dryland, and IIe, irrigated.

31—Shingle clay loam, 2 to 10 percent slopes. This shallow, well drained soil is gently to moderately sloping. It is on upland side slopes. It formed in material weathered from the highly calcareous and gypsiferous shale. Slopes are dominantly complex and about 500 feet in length. The average annual precipitation is about 14 inches.

Typically, the surface layer is yellow clay loam about 4 inches thick. The underlying material, to a depth of 16 inches, is yellow clay loam. Below this is soft shale. The soil, high in sulphates, is calcareous throughout.

Included with this soil in mapping are small areas of Pultney and Singerton soils. Also included is soft, highly weathered shale that is exposed at the surface and makes up about 5 percent of the area. Pultney soils have shale at a depth of 20 to 40 inches, but Singerton soils are deep. The Pultney soils are on hillsides, and the Singerton soils are on foot slopes.

Permeability of this Shingle soil is moderate. Available water capacity is very low. Effective rooting depth is 20 to 40 inches. Where the soil is under native vegetation, the average annual wetting depth is about 10 inches. Surface runoff is rapid, and the hazard of erosion is very high. The hazard of soil blowing is high.

This soil is used for rangeland. The dominant grass is alkali sacaton. Blue grama, sideoats grama, and galleta are abundant. Some areas have stands of sideoats grama. Plants that increase as the range site deteriorates are pricklypear, Fremont goldenweed, pullup muhly, and greasewood. As rangeland deteriorates, the density of the vegetation thins and the soil becomes excessively eroded by wind and water. The presence of princessplume, two-grooved milkvetch, and Fremont goldenweed are indicators of selenium bearing plants.

The goal of good grazing management is to maintain or improve the condition of rangeland. Reestablishing the native plant community by conventional methods is very difficult on this site because of low infiltration rates, which are caused by very fine textured, saline soils, and because of the unstable soil condition. Pitting, making shallow pits to hold water, or chiseling the soil increases intake of water and slows runoff. The most successful method of reseeding grass is to plant the seed by drill in a prepared seedbed, then pit the area. Pitting should be done at a 45 degree angle to the holes that have been drilled to hold seed. The grasses that are most likely to become established by reseeding are alkali sacaton and western wheatgrass.

The soil is not suited to cultivated crops because of shallow depth to shale.

This soil is poorly suited to homesites and to most urban uses. Shallow depth to rock causes septic tank absorption fields to malfunction and makes excavation difficult. Steeper slopes compound the limitations caused by shallow rock. Establishment and maintenance of lawns and gardens is difficult. Special types of concrete are needed because of the high sulphate content of the soil. If possible, a more suitable soil for building should be selected.

This soil is in capability subclass VIe.

32—Singerton-Pultney complex, 1 to 10 percent slopes. This complex consists of deep and moderately deep, well drained soils that are gently sloping to moderately sloping. These soils are on hillsides and ridges. They formed in material weathered from the highly calcareous and gypsiferous shale. Slopes are generally smooth and about 1,000 feet in length. The average annual precipitation is about 13 inches.

This complex is about 45 percent the Singerton soil and about 35 percent the Pultney soil. The Singerton soil is generally on less sloping areas on foot slopes and hillsides.

Included with this complex in mapping are small areas of Stoneham and Shingle soils. Stoneham soils developed in loamy material, which lacks the high concentration of calcium carbonate, and are in smooth areas. Shingle soils are on ridges and have shale at a depth of less than 20 inches.

Typically, the Singerton soil has a layer of light yellowish brown loam about 6 inches thick. Underlying material, to a depth of 60 inches or more, is pale yellow clay loam. The soil, high in sulphates, is calcareous throughout.

Permeability of the Singerton soil is moderate. The available water capacity is moderate. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 12 inches. Surface runoff is medium. The hazards of erosion and soil blowing are high.

Typically, the Pultney soil has a surface layer of light yellowish brown clay loam about 6 inches thick. The underlying material, to a depth of 25 inches, is light yellowish brown grading to pale yellow clay loam. Soft shale is at a depth of about 25 inches. The soil has a high sulphate content and is calcareous throughout.

Permeability of the Pultney soil is moderately slow. The available water capacity is low. The effective rooting depth is 20 to 40 inches. Under native vegetation, the average annual wetting depth of the soil is about 11 inches. Surface runoff is medium. The hazards of erosion and soil blowing are high.

The soil is used mainly for rangeland. A few areas are cropped to dryfarmed wheat.

The soil is well suited to rangeland. The dominant native vegetation is blue grama and galleta, which make up nearly two-thirds of the cover. These two grasses combine with western wheatgrass, sideoats grama, and alkali sacaton. These soils cannot support a high density of plants because of the limited rainfall. Usable forage tends to be reduced. Ideally, plants grow in clumps, but clumps are spaced closely enough to prevent soil blowing. Western wheatgrass, needleandthread, and sideoats grama decrease under mismanagement. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase with deterioration of the rangeland.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Range seeding speeds the revegetation of areas depleted by heavy grazing, cultivation, or other disturbances. Primary varieties used for seeding are blue grama, sideoats grama, and western wheatgrass. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before seeding to establish protection from the wind for the new seeding. Contour furrowing and pitting are applicable in areas where rangeland is in poor and fair condition.

These soils are not suited to dryfarmed crops. Crops are difficult to establish. Seedling mortality is high, and crops suffer from moisture stress. Because of the high lime content, wheat, especially sorghums, develop iron chlorosis. These limitations reduce the amount of plant cover and increase erosion.

Suitability is fair for homesites and for most urban uses. The main limitations are the moderate permeability of the Singerton soil; moderately slow permeability and depth to rock of the Pultney soil; and moderate shrink-swell potential of both soils. Septic tank absorption fields do not function properly in the Pultney soil. Additional leach lines are needed in the Singerton soil if septic tank absorption fields are to function properly. Foundations and roads need to be specially designed to overcome moderate shrink-swell potential. Special concrete is needed in these soils because of the high sulphate content of the underlying material. Saturating soil material adjacent to foundations can be avoided by draining water away from buildings.

This complex is in capability subclass VIe.

33—Stoneham loam, 0 to 3 percent slopes. This deep, well drained soil is nearly level to gently sloping. It is on upland plains. It formed in calcareous, loamy material. Slopes are dominantly smooth and about 1,000 feet in length. The average annual precipitation ranges from 12 to 15 inches.

Typically, the surface layer is brown loam about 4 inches thick. The subsoil extends to a depth of 13 inches. It is brown grading to pale brown clay loam. The substratum, to a depth of 60 inches or more, is pale

brown, light yellowish brown, and very pale brown loam. Where it is plowed, this soil is typically calcareous throughout. In areas of native rangeland, it may be leached to a depth of 10 inches.

Included with this soil in mapping are small areas of Kim soils. Kim soils have a light colored surface and are on knolls. This inclusion varies from 15 percent of the map unit in the central part of the county to as much as 30 percent of the unit in the western part. Light colored, eroded soils are common and are considered part of the Kim inclusion. Also included are small areas of Vona sandy loam, 2 to 3 percent slopes. This soil is on elongated ridges and differs from the other soils by being sandier.

Permeability of this Stoneham soil is moderate. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 18 inches. Surface runoff is medium, and the hazard of erosion is moderate. The hazard of soil blowing is high. Much of the farmed soil has undergone moderate to severe erosion (fig. 2).

The soil is used for rangeland and dryfarmed crops. The main crop is wheat, but minor amounts of forage sorghum and millet are grown.

Suitablity is fair for dryfarming. Intensive management is needed on these soils because of their high hazard of erosion. The main concerns of management are conserving soil moisture, controlling soil blowing, and controlling water erosion. Management used to overcome these limitations are maintaining a cover of plants or stubble on the soil surface at all times, maintaining a cloddy surface, and using minimum tillage, terracing, and stripcropping. A minimum of 1,600 pounds of stubble needs to be retained on the surface at planting time; however, this amount could be reduced if stripcropping is used. When weeding, only equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. Crops respond to nitrogen fertilizer, but nitrogen should only be added when adequate moisture is available. Chiseling breaks up tillage pans and improves water infiltration. Tillage should be kept to a minimum. In periods of drought, a catch crop may need to be planted to protect the soil from blowing.

The soil is well suited to rangeland. The native vegetation consists of blue grama, western wheatgrass, sand dropseed, buffalograss, and sideoats grama. This soil cannot produce a high density of plants because of the

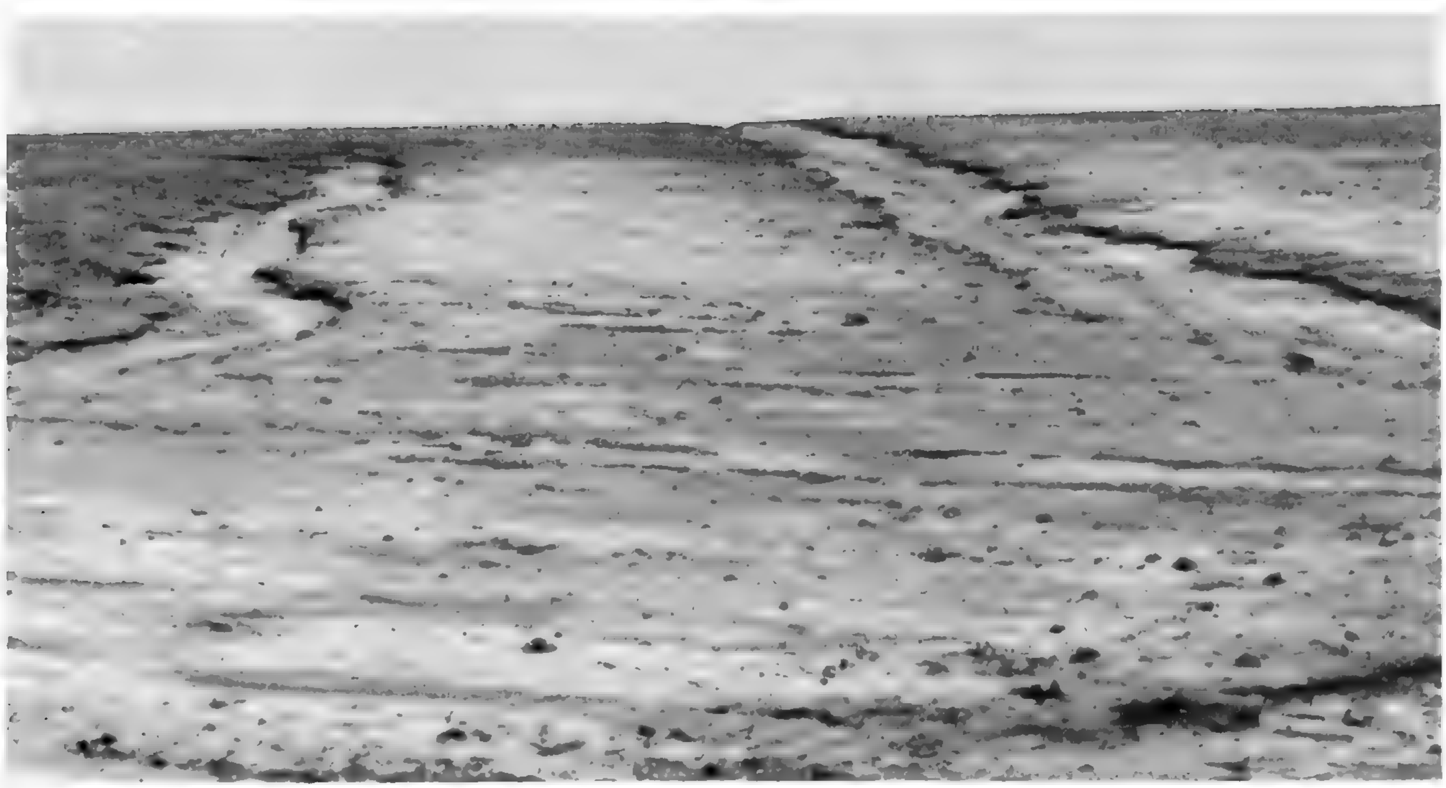


Figure 2.—Water erosion on Stoneham loam, 0 to 3 percent slopes. Contour farming and terracing can correct this loss of valuable topsoil.

limited rainfall. Usable forage tends to be reduced. Ideally, plants grow in clumps, but clumps are spaced closely enough to prevent soil blowing. Western wheatgrass and sideoats grama decrease under mismanagement. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase with deterioration of the rangeland.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Range seeding speeds the revegetation of areas that have been depleted by heavy grazing, cultivation, or other disturbances. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before the grass is to be seeded to establish protection from the wind for the new seeding. Primary varieties for seeding are blue grama, sideoats grama, and western wheatgrass. Contour furrowing or pitting are applicable to areas where rangeland is in poor and fair condition.

The Stoneham soil is well suited to homesites and to most urban uses. The main limitations are moderate permeability and moderate shrink-swell potential. Septic tank absorption fields need to be lengthened to compensate for moderate permeability. The hazard of shrinking and swelling of the soil can be minimized by backfilling around foundations and basements and by avoiding saturation of the soil material around structures. These soil limitations generally are easily overcome.

This soil is in capability subclasses IVe, dryland, and IIe, irrigated.

34—Stoneham-Kim loams, 0 to 2 percent slopes, eroded. This complex consists of deep, well drained soils that are nearly level. These soils are on upland plains. They are formed in calcareous, loamy material. Slopes are smooth, and they are generally about one-half mile in length. The average annual precipitation is about 13 inches.

This complex is about 50 percent the Stoneham soil, eroded, and about 40 percent the Kim soil. The Stoneham soil, eroded, is on flats and forms a matrix around the Kim soil, which is on slight knolls.

Included in mapping are small areas of Pultney soils and the noneroded Stoneham soil. Pultney soils are on hillsides and have shale at a depth of 20 to 40 inches. The noneroded Stoneham soil is in small, concave areas.

Typically, the Stoneham soil has a surface layer of pale brown loam about 4 inches thick. The subsoil is pale brown, calcareous clay loam about 4 inches thick. The substratum, to a depth of 60 inches or more, is very pale brown loam. The original surface layer and upper part of the subsoil have been removed by erosion. The present surface layer is a plow layer in the remaining subsoil. The soil is calcareous throughout.

Permeability of the Stoneham soil is moderate. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 15 inches. Surface runoff is slow, and the erosion hazard is slight. The hazard of soil blowing is high.

Typically, the Kim soil has a surface layer of pale brown loam about 4 inches thick. The underlying material, to a depth of 60 inches, is very pale brown loam. The soil is calcareous throughout.

Permeability of the Kim soil is moderate. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 15 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is high.

These soils are used for dryfarmed crops and for rangeland. Dominant crops grown are wheat and forage sorghums.

These soils are poorly suited to dryfarmed crops. They are very susceptible to soil blowing and have been badly eroded by past farming. The continued use of disk plowing has contributed to soil blowing by removing all crop residues from the surface. The soil is in such poor condition at this time that dryfarming is hazardous. When moisture is adequate, fair yields can be obtained. In the years when rainfall is below average, however, yields are reduced, plant cover is difficult to maintain, and severe soil blowing results. These soils are best left in native grass or reseeded to adapted grasses. Intensive management is needed on these soils because of their high hazard of erosion. The main concerns of management are conserving soil moisture and controlling soil blowing. Management that can overcome these limitations are maintaining a cover of plants or stubble at all times, maintaining a cloddy surface, and using minimum tillage, terracing, and stripcropping. A minimum of 1,600 pounds of stubble needs to be retained on the surface at planting time; however, this amount could be reduced if stripcropping were used. When weeding, only equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. Crops respond to nitrogen fertilizer, but nitrogen should only be added when adequate moisture is available. Chiseling breaks up tillage pans and improves infiltration of water. Tillage should be kept to a minimum. In periods of drought, a catch crop may need to be planted to protect the soil from blowing.

These soils are well suited to rangeland. The native vegetation of blue grama, sand dropseed, and western wheatgrass are the dominant grasses. These soils cannot support a high density of plants because of the limited rainfall. Usable forage tends to be reduced. Ideally, plants grow in clumps, but clumps are spaced closely enough to prevent soil blowing. Western wheatgrass,

needleandthread, and sideoats grama decrease under mismanagement. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase with deterioration of the rangeland.

Proper grazing is the foremost need in rangeland management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Range seeding speeds the revegetation of areas that have been depleted by heavy grazing, cultivation, or other disturbances. A cover crop of sorghum, millet, sudangrass, or small grain needs to be planted a year before the grass is to be seeded to establish protection from the wind for the new seeding. Primary varieties for seeding are blue grama, sideoats grama, and western wheatgrass.

These soils are well suited to homesites and to most urban uses. The main limitations are moderate permeability and moderate shrink-swell potential. Septic tank absorption fields need to be lengthened to compensate for moderate permeability. The hazard of shrinking and swelling of the soils can be minimized by backfilling around foundations and basements and by avoiding saturation of the soil material around structures. These soil limitations are generally easily overcome.

This complex is in capability subclasses IVe, dryland, and IIe, irrigated.

35—Sundance loamy sand. This deep, well drained soil is nearly level. It is on upland plains. It formed in eolian sand that has been deposited on an older, loess hardland. This soil is in a narrow, transitional zone between the sandhills and hardlands, which are deep, loamy areas. Slopes are dominantly smooth and about 1 mile in length. Slope is 0 to 2 percent. The average annual precipitation is about 15 inches.

Typically, the surface layer is yellowish brown loamy sand about 8 inches thick (fig. 3). The subsoil extends to a depth of 45 inches. The upper 9 inches of the subsoil is dark yellowish brown sandy loam. The lower 28 inches is yellowish brown clay loam grading to very pale brown silt loam. The substratum, to a depth of 60 inches or more, is very pale brown silt loam. The soil is calcareous below a depth of about 28 inches.

Included with this soil in mapping are small areas of Bijou and Fort Collins soils. Bijou soils are on small ridges and are more droughty. Fort Collins soils generally are around the edge of the mapping unit. They do not have the thick loamy sand surface layer that the Sundance soil has.

Permeability of this Sundance soil is rapid in the sandy soil material and moderately slow in the subsoil. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 35 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

Figure 3.—Profile of Sundance loamy sand. Sandy material about 14 inches thick over well structured subsoil. Visible calcium carbonate at 25 inches.

This soil is used almost entirely for dryfarmed crops. Grain sorghum is annually cropped on this soil. Some wheat is grown (fig. 4). Growing wheat on this soil is

Figure 4.—Wheat (L) and sorghum (R) production on Sundance loamy sand. Wheat planted in furrows and sorghum planted at 90 degree angle to prevailing wind to prevent soil blowing.

risky because of the hazard of soil blowing. Millet is sometimes grown as a substitute crop when wheat or grain sorghum are lost from drought or soil blowing.

This soil is well suited to dryfarmed crops. It is one of the few soils in the county that can be annually cropped. The Sundance soil is unique in that the loamy sand surface layer absorbs water readily and helps prevent evaporation. The moderately slow permeability of the lower subsoil helps keep the moisture within the root zone.

Because the hazard of soil blowing is very high, this soil is difficult to manage for dryfarmed crops. Leaving stubble standing is essential to protect the soil from blowing. Row crops should be planted at right angles to the prevailing wind, and crops should be harvested so that adequate stubble is left to protect the soil surface. Excessive grazing of crop residues can leave the soil in condition to blow. Tillage pans form on this soil if tilled when wet. Chiseling or subsoiling breaks up pans and improves infiltration of water and penetration of roots into the soil. Terraces are normally not recommended. The most widely accepted method of farming this soil is to plant sorghum in deep furrows by lister, fertilize the plants with anhydrous ammonia, and control weeds by using an herbicide (fig. 5). Anhydrous ammonia should be applied when the soil is moist to help prevent volatilization. If residues are insufficient to keep the soil from blowing, deep listing may be advisable. Other farming alternatives may be using minimum tillage or no tillage and planting in standing stubble. Chiseling to stop soil blowing is generally not effective.

Suitability is fair for homesites and for most urban uses. The main limitations of the soil are moderately slow permeability and moderate shrink-swell potential of the subsoil. Septic tank absorption fields need to be lengthened to compensate for moderately slow permeability. The moderate shrink-swell potential and the moderately slow permeability can be minimized by backfilling around leach lines and foundations or by locating these structures below the subsoil. Avoid saturating the soil material around foundations by directing drainage away from structures.

This soil is in capability subclasses IVe, dryland, and IVe, irrigated.

36—Sundance-Fort Collins complex, 0 to 2 percent slopes. This complex consists of deep, well drained soils that are nearly level. These soils are on upland plains. The Sundance soil formed in eolian sand that has been deposited on an older loess plain. The Fort Collins soil formed in calcareous loamy material. Slopes are dominantly smooth and about one-half mile in length. The average annual precipitation is about 12 to 15 inches.

This complex is about 55 percent the Sundance soil and about 35 percent the Fort Collins soil. The Sundance soil is in areas where sand deposits are deeper,

Figure 5.—Aerial application of herbicide on grain sorghum. Grain sorghum is grown annually on the Sundance soil.

and it has high yields. The Fort Collins soil is in small areas where the sandy deposit is thin. The pattern of crop growth is uneven. This indicates the position of each soil on the landscape.

Included with this complex in mapping are small areas of soils that have a sandy loam surface layer and are on flats and in swales.

Typically, the Sundance soil has a layer of yellowish brown loamy sand about 7 inches thick. The subsoil extends to a depth of 38 inches. The upper 7 inches of the subsoil is dark yellowish brown sandy loam. The lower 24 inches is yellowish brown clay loam grading to very pale brown silt loam. The substratum, to a depth of 60 inches, is very pale brown silt loam. The soil is calcareous below a depth of about 24 inches.

Permeability of the Sundance soil is rapid in the sandy soil material and moderately slow in the subsoil. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 35 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

Typically, the Fort Collins soil has a surface layer of brown sandy loam about 6 inches thick. The subsoil extends to a depth of 26 inches. The upper 8 inches of the subsoil is brown clay loam. The lower 12 inches is pale brown loam. The substratum, to a depth of 60 inches or more, is pale brown loam. The soil is calcareous below a depth of 16 inches.

Permeability of the Fort Collins soil is moderate. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 24 inches. Surface runoff is slow, and the erosion hazard is slight. The hazard of soil blowing is very high.

These soils are used almost entirely for dryfarmed crops. Grain sorghum is annually cropped on these soils. Some wheat is grown; however, the hazard of soil blowing makes growing wheat risky. Millet is sometimes grown as a substitute crop when wheat or grain sorghum is lost from drought or wind erosion.

This soil is well suited to dryfarmed crops. It is one of the few soils in the county that is annually cropped. The Sundance soil is unique in that the loamy sand surface layer absorbs water readily and helps prevent evaporation. The moderately slow permeability of the lower part of the subsoil helps keep the moisture within the root zone.

Because the hazard of soil blowing is very high, these soils are difficult to manage for dryfarmed crops. Leaving stubble standing is essential to protect the soil from blowing. Row crops should be planted at right angles to the prevailing wind, and crops should be harvested so that adequate stubble is left to protect the soil surface. Excessive grazing of crop residues leaves the soil in condition to blow. Tillage pans form on this soil if tilled when wet. Chiseling or subsoiling breaks up pans and

improves infiltration of water and penetration of roots into the soils. Terraces are normally not recommended. The most widely accepted method of farming this soil is to plant sorghum in deep furrows by lister, fertilize the plants with anhydrous ammonia, and control weeds by using herbicides. Anhydrous ammonia should be applied when the soil is moist to help prevent volatilization. If there are insufficient residues to keep the soil from blowing, deep listing may be advisable. Other farming alternatives may be using minimum tillage or no tillage and planting in standing stubble. Chiseling to stop soil blowing is generally not effective.

Suitability is fair for homesites and for most urban uses. The main limitations of the soils are moderately slow permeability and moderate shrink-swell potential of the subsoil. Septic tank absorption fields need to be lengthened to compensate for moderately slow permeability. The moderate shrink-swell potential and the moderately slow permeability can be minimized by backfilling around leach lines and foundations or by locating these structures below the subsoil. Saturating the soil material around foundations can be avoided by directing drainage away from structures.

This complex is in capability subclass IVc, dryland, and class IV, irrigated.

37—Valent loamy sand, 3 to 10 percent slopes. This deep, excessively drained soil is gently to strongly sloping. It is on dunes in the sandhills. It formed in noncalcareous, eolian sands. Slopes are dominantly complex and about 75 feet in length. The average annual precipitation is about 14 inches.

Typically, the surface layer is brown loamy sand about 5 inches thick. The underlying material, to a depth of 60 inches or more, is yellowish brown to light yellowish brown sand. The soil is noncalcareous throughout.

Included with this soil in mapping are small areas of Bijou soils, which have a sandy loam subsoil.

Permeability of this Valent soil is very rapid. Available water capacity is low. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 60 inches. Surface runoff is very slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

The soil is used for rangeland, and it is well suited to this use. Important livestock wintering areas are located on this soil. Winter forage is abundant, and livestock is protected during blizzards. These areas are often used for spring calving.

The rangeland has a native vegetation consisting of sand bluestem, prairie sandreed, switchgrass, sideoats grama, little bluestem, sand dropseed, and blue grama. These furnish most of the forage. Scattered stands of sand sagebrush are throughout the vegetation.

The goal of proper grazing management is to maintain or improve rangeland condition. Soil moisture penetrates deeper into these soils than into the deep, loamy hardlands. It is important to maintain tall, deep rooted grasses in the stand to use the deeply stored moisture. Without management of grazing, the plant cover loses the tall, productive grasses. Deferred grazing is highly effective in management systems for livestock. Sand sagebrush or yucca form a dense stand if heavy grazing is continued. This brush needs to be controlled. Range seeding is needed in severely depleted areas. This range site can be reseeded with sand bluestem, prairie sandreed, switchgrass, sideoats grama, and little bluestem by using a grass drill capable of handling seed mixed with trash, such as stems, husks, and leaves. Seeding into a cover crop is necessary to keep the soil from blowing during seedling establishment. Using equipment that seeds grass into the cover with a minimum of disturbance may be desirable to avoid establishing a seedbed. Placement of facilities for watering livestock aids in the desired distribution of grazing, but watering facilities must not be located in places where serious soil blowing causes blowouts. Grazing management should leave a good height of forage standing to protect the soil from blowing and to catch and hold snow.

This soil is not suited to dryfarming, because it has low water capacity, is droughty, and is very susceptible to soil blowing.

The soil is well suited to homesites and to most urban uses. Special care needs to be taken to control erosion during construction. Septic tank absorption fields function well; however, a high density of effluent could pollute shallow wells. Sewage lagoons need to be sealed properly. Excavations are difficult because banks cave in. This soil is used as a source of sand in construction.

This soil is in capability subclasses VIe, dryland, and IVe, irrigated.

38—Valent-Blownout land complex, 2 to 8 percent slopes. This complex consists of deep, excessively drained soils that are gently to moderately sloping. These soils are in sandhills that have been severely eroded by soil blowing. They formed in noncalcareous, eolian sand. Slopes are dominantly complex and about 50 feet in length. The average annual precipitation is about 14 inches.

This complex is about 40 percent Valent loamy sand and about 40 percent blownout areas. Some blowouts have been stabilized, but others are actively eroding.

Included with this complex in mapping are small areas of Bijou soils. Bijou soils differ from Valent soils in having a sandy loam subsoil.

Typically, the Valent soil has a surface layer of brown loamy sand about 5 inches thick. The underlying material, to a depth of 60 inches or more, is yellowish brown to light yellowish brown sand. The soil is noncalcareous throughout.

Permeability of the Valent soil is very rapid. Effective rooting depth is 60 inches or more. Available water capacity is low. Where this soil is under native vegetation,

the average annual wetting depth is about 60 inches. Surface runoff is very slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

The blownout parts of this map unit are usually elongated areas lying in a north-south or northwest-southeast direction (fig. 6). They are bare or may be vegetated by large numbers of yucca plants. The blowouts are the result of overgrazing by livestock or plowing.

This complex is best suited to rangeland. The native vegetation is prairie sandreed, sand bluestem, switchgrass, little bluestem, sideoats grama, sandhill muhly, and sand dropseed. Careful grazing management is essential on this soil to prevent overgrazing, which destroys the protective plant cover and causes serious soil blowing. Because overgrazing has destroyed the tall, deep rooted grasses, blowouts have developed. Watering places for livestock should not be located on these soils, because concentrations of animals is destructive. This depletes rangeland cover. Mechanical conservation treatment is not practical on these soils. Fencing of these blowouts from livestock grazing is most essential.

After a cover crop is established, these areas can be reseeded to sand bluestem, prairie sandreed, switchgrass, sideoats grama, and little bluestem. It is impossible to expect permanent revegetation unless the shifting sand is stopped. Seeding of 3 to 6 rows of medium size trees and shrubs at intervals of no more than 440 feet apart, at right angles to the prevailing winds, assists in reducing shifting sand and in establishing a stand of grass. Trees and shrubs that are suitable for wildlife

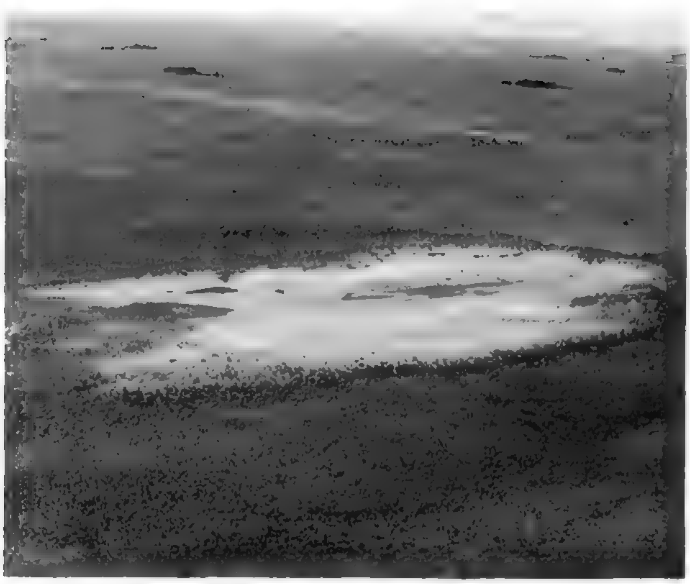


Figure 6.—Valent-Blownout land complex, 2 to 8 percent slopes. These blowouts form when native vegetation is disturbed by overgrazing or plowing in sandhills.

should be used also. Suitable trees for blowout areas are eastern red cedar, Rocky Mountain juniper, and ponderosa pine. Suitable shrubs are green ash, Russian-olive, caragana, sumac, and house hedge rose.

This soil is not suited to dryfarmed crops, because the hazard of soil blowing is very high.

Because of the hazard of soil blowing, this complex is poorly suited to houses and other urban uses. If the erosion hazard is corrected, it is well suited to urban uses. Septic tank absorption fields function well; however, a high density of effluent could pollute shallow wells. Sewage lagoons need proper sealing. Excavations are difficult because banks cave in.

This complex is in capability subclass VIIe.

39—Vona sandy loam, 1 to 3 percent slopes. This deep, well drained soil is nearly level to gently sloping. It is on upland plains. It formed in calcareous, eolian, sandy material. Slopes are dominantly slightly undulating and about 300 feet in length. The average annual precipitation is about 14 inches.

Typically, the surface layer is brown sandy loam about 4 inches thick. The subsoil extends to a depth of 16 inches. It is dark yellowish brown grading to brown sandy loam. The substratum, to a depth of 60 inches or more, is brown sandy loam grading to very pale brown loamy sand. The soil is calcareous below a depth of 8 inches.

Included with this soil in mapping are small areas of Fort Collins, Kim, and Otero soils. Fort Collins soils have high available water capacity and are in swales. Kim soils also have high available water capacity and are calcareous throughout. Otero soils are badly eroded and are more susceptible to soil blowing. Kim and Otero soils are on ridges and hillsides.

Permeability of this Vona soil is moderately rapid. Available water capacity is moderate. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 25 inches. Surface runoff is slow, and the hazard of erosion is slight. The hazard of soil blowing is very high.

This soil is used for rangeland and for dryfarmed crops. The main crops grown are wheat, forage sorghum, and millet.

This soil is poorly suited to dryfarmed crops. The sandy surface layer increases infiltration of water; however, it is very susceptible to blowing. Stable clods are difficult to form on the soil, and blowing sand is abrasive to crops and stubble. It is very difficult to keep soil from blowing on small knolls. The soil is droughty, because it lacks the ability to store large quantities of moisture. Management that can be used to control soil blowing and to conserve moisture include maintaining a cover of plants or stubble on the surface at all times and using minimum tillage, terracing, and stripcropping. A minimum of 1,400 pounds of stubble needs to be retained on the surface at planting time; however, this amount could be reduced if stripcropping is used. When weeding, only

equipment that cuts plant roots below the surface should be used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. Tillage pans form easily if the soil is tilled when wet. Chiseling or subsoiling breaks up pans and improves infiltration of water and penetration of roots into the soil. Tillage needs to be kept to a minimum. In droughty periods, a catch crop may need to be planted to keep the soil from blowing.

The soil is well suited to rangeland. The native vegetation is blue grama, a typical bunch grass, which is 1/3 to 1/2 of the cover. Other frequent species are sand dropseed, little bluestem, and sideoats grama. If rangeland is in a deteriorated condition, blue grama increases at first, but, under continued heavy grazing, it decreases and is replaced by threeawn, pricklypear cactus, undesirable forbs, and annual vegetation.

Seeding is advisable if the rangeland is in a deteriorated condition. Primary grasses for seeding are the native grasses, such as blue grama, sideoats grama, and little bluestem. If the rangeland is severely eroded and blowouts have developed, the new seeding needs to be fertilized. A cover crop of sorghum, millet, sudangrass, or small grain should be planted a year before the grass is to be seeded to establish protection for the new seeding. Using equipment that seeds grass into the cover crop with a minimum of disturbance may be desirable if the potential for serious crop failure exists. Brush control and grazing management help improve the depleted range. Grazing management should leave a good height of forage standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

This soil is well suited to homesites and to most urban uses, if soil blowing is controlled. The soil limitations are easily overcome. Sewage lagoons need to be sealed properly in this soil.

This soil is in capability subclasses IVe, dryland, and IIIe, irrigated.

40—Vona-Stoneham sandy loams, 1 to 10 percent slopes. This complex consists of deep, well drained soils that are nearly level to moderately sloping. These soils are on upland plains. The Vona soil formed in calcareous, eolian sandy material. The Stoneham soil formed in calcareous loamy material. Slopes are undulating and about 200 feet in length. The average annual precipitation ranges from 12 to 15 inches.

This complex is about 55 percent the Vona soil and about 35 percent the Stoneham soil. The Vona soil is on hillsides, ridges, and higher parts of the landscape. Stoneham soils are generally on foot slopes and in small swales.

Included with this complex in mapping are a few small areas of Kim soils, which are calcareous throughout. They are on hillsides.

Typically, the Vona soil has a surface layer of brown sandy loam about 4 inches thick. The subsoil extends to a depth of 16 inches. It is dark yellowish brown grading to brown sandy loam. The substratum, to a depth of 60 inches or more, is brown sandy loam grading to very pale brown loamy sand. The soil is calcareous below a depth of 8 inches.

Permeability of the Vona soil is moderately rapid. The available water capacity is low to moderate. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 22 inches. Surface runoff is medium, and the erosion hazard is moderate. The hazard of soil blowing is very high.

Typically, the Stoneham soil has a surface layer of brown sandy loam about 4 inches thick. The subsoil extends to a depth of 13 inches. It is brown grading to pale brown clay loam. The substratum, to a depth of 60 inches or more, is pale brown, light yellowish brown, and very pale brown loam. The soil is generally calcareous below a depth of 8 inches.

Permeability of the Stoneham soil is moderate. The available water capacity is high. The effective rooting depth is about 60 inches. Under native vegetation, the average annual wetting depth of the soil is about 16 inches. Surface runoff is medium, and the erosion hazard is moderate. The hazard of soil blowing is very high.

These soils are used for rangeland and are well suited to this use. The native vegetation on this site is blue grama, a typical bunch grass, which makes up 1/3 to 1/2 of the cover. Other frequent species are sand dropseed, little bluestem, and sideoats grama. If range condition is deteriorated, blue grama increases at first, but under continued heavy use, decreases and is replaced by threeawn, pricklypear cactus, undesirable forbs, and annual vegetation.

In a deteriorated condition, the rangeland can be seeded to native grasses, such as blue grama, sideoats grama, and little bluestem. If the rangeland is severely eroded and blowouts have developed, the new seeding needs to be fertilized. A cover crop of sorghum, millet, sudangrass, or small grain should be planted a year before the grass is to be seeded to establish protection from the wind for the new seeding. Using equipment that seeds grass into the cover crop with a minimum of disturbance, may be desirable if the potential for serious crop failure exists. Brush control and grazing management help improve the depleted rangeland. Management of grazing animals should leave a good height of forage standing to protect the soil from blowing, to increase infiltration of water, and to catch and hold snow.

These soils are not suited to dryfarming because of the high hazard of erosion and the very high hazard of soil blowing.

These soils are well suited to homesites and to most urban uses. The main limitations are the moderate permeability and moderate shrink-swell potential of the Stoneham soil. Septic tank absorption fields need to be lengthened to compensate for moderate permeability.

The shrink-swell hazard can be minimized by backfilling around foundations and basements and by avoiding saturation of the soil material around structures. These limitations can be avoided by building on the Vona soil, which has low shrink-swell potential and moderately rapid permeability.

This complex is in capability subclass VIe.

41—Wiley loam. This deep, well drained soil is nearly level to gently sloping. This soil is on upland plains. It formed in loess. Slopes are dominantly smooth and about one-half mile in length. Slope is 0 to 3 percent. The average annual precipitation ranges from 13 to 16 inches.

Typically, the surface layer is brown loam about 5 inches thick. The subsoil extends to a depth of 30 inches. The upper 11 inches is pale brown silty clay loam. The lower 14 inches is pale brown silt loam. The substratum, to a depth of 60 inches or more, is pale brown silt loam. The soil is calcareous throughout.

Included with this soil in mapping are small areas of Colby and Baca soils. Colby soils have a lighter colored surface layer, are more erosive than this Wiley soil, and are on knolls. Baca soils are less erosive than this Wiley soil, and are in small swales and drainageways.

Permeability of this Wiley soil is moderate. Available water capacity is high. Effective rooting depth is about 60 inches. Where the soil is under native vegetation, the average annual wetting depth is about 15 inches. Surface runoff is medium, and the hazard of erosion is moderate. The hazard of soil blowing is high. Where this soil has been farmed, it has undergone moderate to severe erosion.

The soil is used for rangeland and dryfarmed crops. The main crop is wheat. Minor amounts of forage sorghum and millet are grown.

The soil has fair suitability for dryfarming, if compared to other soils in Kiowa County. Intensive management is needed on these soils because of the high hazard of erosion. The main concerns of management are conserving soil moisture, controlling soil blowing, and controlling water erosion. Management includes maintaining a cover of plants or stubble at all times, maintaining a cloddy surface, and using minimum tillage, terracing, and stripcropping (fig. 7). A minimum of 1,600 pounds of stubble needs to be retained on the surface at planting time; however, the amount could be reduced if stripcropping is used. This provides the desired roughness on the surface and leaves stubble mulch to catch and hold snow. Crops respond to nitrogen fertilizer, but nitrogen should only be added when adequate moisture is available. Chiseling breaks up tillage pans and improves infiltration of water. Tillage should be kept to a minimum.

Figure 7.—Stripcropping reduces the wind velocity near the surface of this dominantly Wiley loam soil, thereby reducing soil blowing and evaporation losses.

The soil is well suited to rangeland. The native vegetation of blue grama and galleta makes up nearly two-thirds of the vegetative cover. These two grasses combine with western wheatgrass and sideoats grama to form a mixed community. This soil cannot support a high density of plants because of the limited rainfall. Usable forage tends to be reduced. Ideally, plants grow in clumps, but clumps are spaced closely enough to prevent soil blowing. Western wheatgrass and sideoats grama decrease under mismanagement. Threeawn, sand dropseed, pricklypear, snakeweed, and ring muhly increase with deterioration of the rangeland condition.

Proper grazing is the foremost need in range management. Fifty percent, by weight, of the forage needs to be left standing to protect the soil from blowing, to increase the infiltration of water, and to catch and hold snow. Range seeding speeds the revegetation of areas that have been depleted by heavy grazing, cultivation, or other disturbances. Primary varieties used for seeding are blue grama, sideoats grama, and western wheatgrass. A cover crop of sorghum, millet, sudangrass, or small grain should be planted a year before the grass is to be seeded to establish protection from the wind for the new seeding. Contour furrowing or pitting is applicable in areas where the rangeland is in poor and fair condition.

The Wiley soil is well suited to homesites and to most urban uses. The main limitations are moderate permeability and moderate shrink-swell potential. Septic tank absorption fields need to be lengthened to compensate for moderate permeability. The hazard of shrinking and swelling of the soil can be minimized by backfilling around foundations and basements and by avoiding saturation of the soil material around structures. These soil limitations are generally easily overcome.

This soil is in capability subclasses IVe, dryland, and IIe, irrigated.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for crops, pasture, and rangeland; as sites for buildings, highways and other transportation systems, and sanitary facilities; and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section "Soil maps for detailed planning." Planners of management systems for individual fields or farms should also consider the detailed information given in the description of each soil.

Dry cropland

B. W. Greb, soil scientist, Agricultural Research Service, assisted in preparing this section.

About 60 percent of the acreage in Kiowa County is cropland. The climate is the principal limiting factor to dryfarmed crop production. Low, erratic precipitation in combination with high wind velocities make dryfarming a risk.

Using summer fallow is a necessity on deep, loamy hardlands. It enables the soil to store sufficient water and to accumulate nitrates to assure a consistent wheat crop.

Although maintaining the soil in fallow reduces the probability of extreme water stress to wheat, soil blowing annually threatens during late winter. From mid-February until early April, the winter wheat plant is losing its fall root system, but the spring root system has not initiated growth. The wheat plant is poorly anchored and highly vulnerable to damage during this period. The surface of the soil by mid-February frequently becomes ashy looking and powdery. Soil clods resistant to the wind are greatly weakened by freezing and thawing and wetting and drying during the long, dormant period. The probability of unusually high winds is greater during February through April. All these factors contribute to soil blowing, which makes wheat farming marginal in Kiowa County.

About 30 percent of the total precipitation comes as light showers that only moisten the upper few inches of the soil. These sporadic rains are more effective in soils that have a sandy surface layer than in deep, loamy hardlands. For this reason, some sandy soils are able to be cropped annually.

Most precipitation falls faster than the soil can soak it up; therefore, moisture is lost through runoff. This loss is highly variable, but, with ordinary management, it can exceed 50 percent of the rainfall. Studies on the eastern Colorado silt loams have shown that these soils soak up moisture at rates of less than 1/4 of an inch to 3 inches per hour, depending on the condition of the upper part of the soil. Soils on which all vegetation was removed during fallow, have exhausted much of the tilth-forming organic matter and humus. Moisture is taken in more slowly. The soil can be built up to absorb moisture at a rate of 1.5 to 2 inches per hour by incorporating good stubble mulch and residue into the soil.

Terraces are an effective way to reduce runoff, therefore reducing erosion and conserving soil moisture (fig. 8). Terraces are not normally recommended on soils that have a loamy sand surface layer, because soil blowing is a hazard. If the soils of terrace channels are fertilized with nitrogen and phosphorus in wet years, they can be cropped annually. Cropping terraces could be especially useful in the eastern part of the county where precipitation is greater. Before fertilization or annual cropping, the soil in terrace channels should be checked to make sure adequate moisture has been stored. Using contour stripcropping between terraces is an effective method of reducing both soil blowing and water erosion. If contour strips are parallel to the wind direction, soil blowing can be a concern.

Blustering winds often cause damage to crops (fig. 9). Not only does dry wind cause a rapid increase in evaporation, but it moves loose soil particles along the surface, which causes injury to plants and the soil (*8*). The organic part of the soil is easily removed by wind, leaving the relatively infertile, coarser soil material. This process gradually reduces the quality of the soil.

Evaporation of moisture from the soil surface is considerable. The moisture in the upper 4 to 6 inches of the soil is often lost through evaporation. Weeds compete with crops for moisture and fertility. In controlling weeds, the surface soil is often stirred up, causing more evaporation. Research has shown that an average of 0.3 to 0.5 inch of water evaporates each time the soil is tilled; therefore, it is important to keep tillage to a minimum.

Keeping a cover on the soil is essential to reduce erosion, to improve moisture infiltration, and to reduce evaporation (*8*). Stubble mulch tillage is an effective way to keep the soil covered (*8*). Using tillage equipment that cuts into the subsurface with a minimal disturbance to the surface can be used effectively to leave stubble. The use of this equipment alone, however, does not assure an adequate stubble mulch program. When weeding, sweeps are often used at too shallow a depth and are pulled too fast. This causes more residue than necessary to be incorporated into the soil. Sweeps should be set at a depth of about 4 inches or more and pulled slowly enough to leave stubble standing upright (fig. 10). Standing stubble is effective in reducing wind erosion and catching blowing snow. Also, the proper use of sweeps produces a desirable cloddy surface to protect the soil from blowing.

The use of chemicals to control weeds during the fallow season is an effective aid to stubble mulch tillage. Using chemicals improves moisture efficiency and provides more protection from erosive winds, because it minimizes tillage, which allows more residue to be left on the surface to catch snow and to protect the soil. Preemergence herbicides have been effectively used to control weeds during the fall after harvest and through early summer of the following year. When the chemical becomes ineffective, tilling once or twice is necessary to control weeds and prepare the seedbed for the following crop.

Stripcropping is an effective tool in controlling soil blowing and can be especially beneficial on erosive, sandy soils (*8*). Width of strips is determined by the texture of the soil surface, the amount of residue that can be maintained, and climate.

Surface roughness is an important aspect of the management of soils for dryfarmed crops. Soil clods not only increase water penetration; they also help prevent soil

Figure 8.—Flat channel terraces on Baca-Wiley complex, 0 to 1 percent slopes. Terraces can be effective in storing water, even on nearly level soil, and can increase yields of channels.

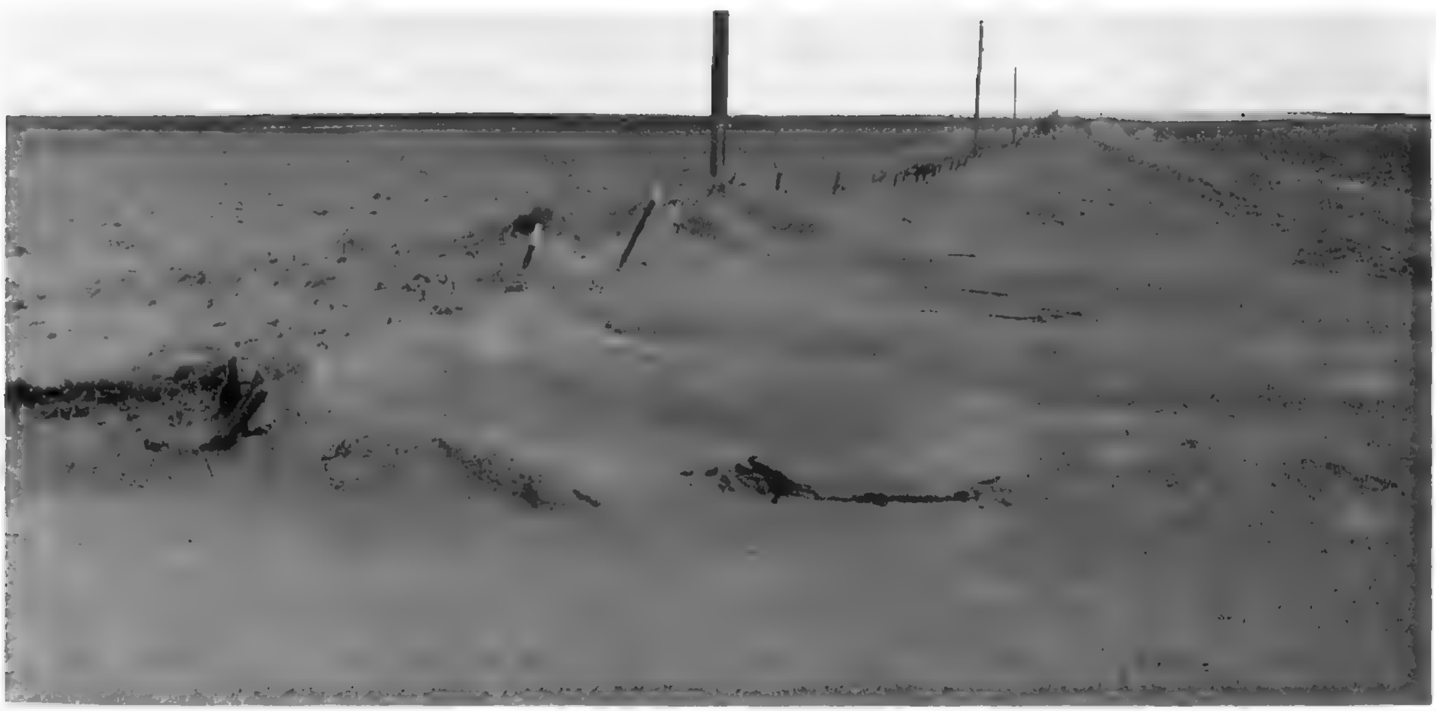


Figure 9.—The result of severe soil blowing on unprotected Fort Collins sandy loan, 0 to 3 percent slopes. As much as 50 tons per acre can be removed by one severe storm.

Figure 10.—Farmer is sweeping a fallowed area of Wiley loam to control weed growth. Such subsurface equipment as sweeps control weeds but leaves stubble on the surface to protect against soil blowing.

blowing by protecting the easily erodible material. Cloddiness depends mainly on content of clay, organic matter, and lime.

Sandy soils or soils that contain lime in the surface layer form clods only when adequate moisture is available. Such clods are readily broken down by rainfall, freezing and thawing, or by tillage. A soil is described as cloddy if 50 percent of the surface is covered with clods more than 0.4 inch in diameter. Disk plowing not only buries the mulch residue, it pulverizes the surface soil and reduces the size and amount of clods. It should be used only when crop residues are extremely heavy.

The surface can also be roughened by ridging the soil perpendicular to the prevailing wind direction. This is a common practice during droughty years or when inadequate residue is left on the surface during the critical periods of wind erosion (fig. 11).

One of the most important aspects of dryfarming in Kiowa County is to store moisture in the soil and use the moisture efficiently.

During periods of drought, two fallow seasons may be needed to store enough water to produce a crop. In periods of unusually heavy rainfall, however, annual cropping may be possible. The key to management is to know how much moisture has been stored. About 6 inches of water is required to establish a stand of wheat. To store this amount of water, medium textured soils, such as Fort Collins, Stoneham, and Wiley soils, need moisture to a depth of about 4 feet. The amount of moisture in the soil can be checked by digging down and checking the subsoil. The soil should form into a relatively durable ball when it is squeezed in the hand. More depth is required in sandy soils to make the same amount of water available to plants. Vona and Bijou soils, for example, need to be moist to a depth of about 6 feet.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not

Figure 11.—About 1,500 pounds of stubble is left on this Richfield silt loam, 0 to 1 percent slopes, to protect against soil blowing and conserve moisture. Surface roughness increases water infiltration and reduces erosion.

suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and the soil. A few farmers may be obtaining average yields higher than those shown in table 5.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage practices, including time of tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvesting crops with the smallest possible loss; and timeliness of all fieldwork.

The estimated yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not included because the acreage of these crops is small. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the management concerns and productivity of the soils for these crops.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take

into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system (*5*), all kinds of soil are grouped at three levels: capability class, subclass, and unit. Two of these levels are defined in the following paragraphs. A survey area may not have soils of all classes.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and landforms have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability subclass is identified in the description of each soil mapping unit in the section "Soil maps for detailed planning."

Rangeland

Edward C. Dennis, range conservationist, Soil Conservation Service, assisted in preparing this section.

About 40 percent of Kiowa County is rangeland. Ranches are intermingled with land being cropped. The average farm is 2,600 acres; however, the average ranch is about 10,000 acres of rangeland and a section or two of cultivated cropland. The cow-calf-yearling operation is the dominant type of ranch.

On many of the ranches, forage produced on rangeland is supplemented by wheat pasture. During the winter months, the native forage is supplemented by a protein supplement, generally cottonseed cake. Creep feeding of calves and yearlings is practiced on some ranches.

The native vegetation in many parts of the county shows that the rangeland has been well managed. It has deteriorated on the deep sands and sandy plains range site. This range site has been so heavily grazed that the taller grasses were destroyed and were replaced by sand sagebrush. Productivity of the rangeland can be increased by management that is effective for specific kinds of soil and range sites. Brush control and reseeding depleted sites increases the grazing potential.

During the late 1950's, soil that was not suited to cultivation was placed in the Conservation Reserve Program, Soil Bank, and was reseeded to grass. Ideally all soils not suited to farming should be reseeded and returned to grazing, but in Kiowa County, like many other counties, economic pressures lead to continued cultivation of land that is marginal for farming.

This land is ideally suited to the grazing of livestock. Many acres of rangeland are damaged each year by soil blowing from the adjacent cropland.

Where climate and topography are about the same, differences in the kind and amount of vegetation that rangeland can produce are related closely to the kind of soil. Effective management is based on the relationships among soils, vegetation, and water.

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegeta-

tion has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic vegetation of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed by common name. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site.

The soils derived from shale parent material are saline and fine textured. These soils support alkali sacaton, galleta, western wheatgrass, and blue grama. They are excellent grazing lands. These soils are predominately in the western part of the county. Sandy soils make excellent grazing ranges that support the potential plant community of sand bluestem, switchgrass, indiangrass, little bluestem, and sideoats grama. Unfortunately most of this type of rangeland has been overgrazed. The tall and mid grasses that were once there have been replaced by sand sagebrush. The rest of the county, along the southern and northern boundaries, is made up of medium textured soils that support blue grama and buffalograss. The vegetative cover includes western wheatgrass and needlegrass. Areas that have been overgrazed have a high percent of buffalograss in the plant composition and little wheatgrass and needlegrass.

The major concern of range management is to control cropping or grazing so that the kinds and amounts of plants that make up the potential plant community can be reestablished. Proper grazing, fencing, water development, brush control, deferred grazing systems, mechanical control, and reseeding minimize soil erosion and conserve water. Sound management of rangeland and planning based on soil survey information and range site inventories, will result in increased production.

Windbreaks and environmental plantings

Windbreaks are established to protect livestock, buildings, and yards from wind and snow. Windbreaks also help protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broad-leaved and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil. They protect cropland and crops from wind, hold snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. A healthy stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Windbreaks and environmental plantings are difficult to establish in the dry climate of Kiowa County. Supplemental moisture is needed to insure survival. Trees could be planted in diversion channels to provide additional moisture. Water can also be applied through irrigation. Drip irrigation systems are being used effectively to supplement moisture supply. Continued cultivation for weeds is needed to insure establishment and survival of plants. Protection should be provided for young seedlings from abrasive blowing soil and rodents. Rocky Mountain juniper, eastern redcedar, ponderosa pine, Siberian elm, Russian-olive, and hackberry trees survive best on soils that are deep, well drained, and do not have a salinity problem. Shrubs best suited are skunkbush sumac, lilac, Siberian peashrub and American plum.

Windbreaks and environmental plants are generally not recommended on soils that are shallow or are affected by salinity.

Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service, the Cooperative Extension Service, or from nurserymen.

Engineering

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational uses; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 7 shows, for each kind of soil, the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 10, for water management. Table 9 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have a special meaning in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 7. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or

extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 7 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 7 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 8 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight*, soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good*, *fair*, or *poor*, which, respectively, mean about the same as the terms *slight*, *moderate*, and *severe*.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavat-

ed trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation, because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 8 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 9 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 12 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 9 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 12.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from

these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can limit or prevent plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 10 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Wildlife habitat

Eldie Mustard, biologist, Soil Conservation Service, assisted in preparing this section.

The main types of wildlife in Kiowa County include most wildlife species that are common to the plains. In addition to the wildlife mentioned in the paragraphs on openland and rangeland habitat, parts of Kiowa County are important to migrating birds. Large storage basins, such as Nee-Noshe, Blue Lake, and Queens reservoirs, are inhabited by geese and ducks. These birds feed in fields, especially in the Prairie Queen area.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

In table 11, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; selecting areas that are suitable for wildlife; selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; and determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most

places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are Russian-olive, skunkbush sumac, caragana, fourwing saltbush, sand sagebrush, and tamarisk.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include mourning dove, Canada goose, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include jackrabbit, antelope, kit fox, coyote, prairie dog, burrowing owl, mule deer, meadowlark, lark bunting, golden eagle, scaled quail, and horned lark.

Soil properties

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 12 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 12 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 12 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*).

The *Unified* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 12. Also in table 12 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and chemical properties

Table 13 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Clay is a mineral soil particle that is less than 0.002 millimeters in diameter.

In table 13, the estimated clay content of each major soil horizon is given as a percent, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence the shrink-swell potential, permeability, and plasticity; the ease of soil dispersion; and other soil properties. The amount and kind of clay in a soil also affects tillage and earth-moving operations.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

The solum ranges from 15 to 30 inches in thickness. Carbonates are at a depth of 10 to 20 inches.

The A horizon ranges from mildly alkaline to moderately alkaline.

The B horizon is clay loam or heavy loam. In some pedons the upper part of this horizon may be sandy clay loam. Clay ranges from 25 to 35 percent. Reaction is neutral to moderately alkaline.

The C horizon is loam or clay loam. Reaction ranges from mildly alkaline to strongly alkaline.

Glenberg series

The Glenberg series consists of deep, well drained soils that are nearly level. These soils are on terraces and flood plains. They formed in sandy alluvium deposited by intermittent streams. Slope is 0 to 1 percent. The average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Glenberg fine sandy loam in an area of Bankard-Glenberg complex, 1,960 feet south and 2,000 feet west of the northeast corner of sec. 24, T. 19 S., R. 46 W., about 3 miles south and 1 mile east of Chivington:

A1—0 to 5 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse platy structure; slightly hard, very friable; slightly sticky and slightly plastic; slightly calcareous; moderately alkaline; abrupt smooth boundary.

C—5 to 60 inches; pale brown (10YR 6/3) sandy loam stratified with thin lenses of loamy sand to clay loam, brown (10YR 5/3) moist; typical texture is sandy loam; massive parting to single grained when crushed; slightly hard to hard, very friable, nonsticky and nonplastic; slightly calcareous; moderately alkaline.

The solum ranges from 3 to 12 inches in thickness. Calcareous material is typically at the surface or may be leached from the upper few inches.

The A horizon is mildly alkaline to moderately alkaline.

The C horizon is variable in texture, because it is stratified. Texture ranges from sand to clay loam. The typical texture is sandy loam. Weighted average percentage of rock fragments ranges from 0 to 15 percent. The C horizon is slightly calcareous to moderately calcareous; however some of the thin strata are commonly noncalcareous. Reaction ranges from moderately alkaline to strongly alkaline. In some pedons this horizon has mottles in the lower part.

Goshen series

The Goshen series consists of deep, well drained soils that are nearly level. These soils are in drainageways. They formed in alluvium. Slope is 0 to 1 percent. The average annual precipitation is about 17 inches.

Typical pedon of Goshen silt loam, 2,400 feet east and 1,500 feet south of the northwest corner of sec. 11, T. 19 S., R. 42 W., about 4 miles south of Towner:

A1—0 to 5 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; neutral; clear smooth boundary.

B1t—5 to 20 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to very fine angular blocky; slightly hard, friable, sticky and plastic; few thin clay films on faces of peds; mildly alkaline; clear smooth boundary.

B21t—20 to 28 inches; dark grayish brown (10YR 4/2) silty clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate fine angular blocky; hard, firm, sticky and plastic; few thin clay films on faces of peds; mildly alkaline; gradual smooth boundary.

B3t—28 to 36 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to moderate fine angular blocky; hard, firm, sticky and plastic; few thin clay films on faces of peds; mildly alkaline; abrupt smooth boundary.

C—36 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable, sticky and plastic; calcium carbonate visible as few soft nodules, as powder coatings, and in thin seams; moderately calcareous; mildly alkaline.

The thickness of the mollic epipedon ranges from 20 to 40 inches. Thickness of solum and depth to calcareous material range from 32 to 60 inches.

The A horizon has granular or platy structure. Reaction is neutral to mildly alkaline.

The B horizon is silty clay loam or heavy silt loam. Clay ranges from 23 to 35 percent. Reaction is mildly alkaline or moderately alkaline.

The C horizon is silty clay loam, silt loam, or loam. Reaction is mildly alkaline to moderately alkaline.

Harvey series

The Harvey series consists of deep, well drained soils that are nearly level to gently sloping. These soils are on plains and side slopes in uplands. They formed in mixed, calcareous, loamy deposits that are both alluvial and eolian. Slope is 1 to 3 percent. The average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Harvey loam in an area of Kim-Harvey loams, 1 to 3 percent slopes, 75 feet south and 160 feet east of the northwest corner of sec. 18, T. 20 S., R. 54 W., about 8 miles west of Arlington:

Ap—0 to 5 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; weak fine granular struc-

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action results from the movement of soil moisture into the freezing temperature zone in the soil, which causes ice lenses to form. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Soil morphology and classification

In this section, the soil series recognized in the survey area are described, the current system of classifying soils is defined, and the soils in the area are classified according to the current system.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual (*5*).

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Absted series

The Absted series consists of deep, well drained soils that are nearly level. These soils are on terraces. They formed in clayey alluvium washed from weathered shale.

Slope is 0 to 2 percent. The average annual precipitation is about 13 inches.

Typical pedon of Absted clay, 0 to 1 percent slopes, 1,400 feet east and 50 feet north of the southwest corner of sec. 10, T. 20 S., R. 53 W., about 1 mile south of Arlington:

A1—0 to 3 inches; yellowish brown (10YR 5/4) clay, dark yellowish brown (10YR 4/4) moist; moderate very fine granular structure; hard, friable, sticky and plastic; slightly calcareous; moderately alkaline; abrupt wavy boundary.

B21t—3 to 6 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; moderate very fine angular blocky structure; extremely hard, firm, sticky and very plastic; few thin clay films on faces of peds; slightly calcareous; strongly alkaline; clear wavy boundary.

B22tsa—6 to 12 inches; grayish brown (10YR 5/2) clay, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure; extremely hard, friable, sticky and very plastic; few thin clay films on faces of peds; calcium carbonate, calcium sulphate, and other salts visible in the form of seams and fine crystals; moderately calcareous; strongly alkaline; gradual wavy boundary.

B3sa—12 to 16 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; weak coarse angular blocky structure; extremely hard, friable, sticky and very plastic; few fine crystals of calcium sulphate; moderately calcareous; strongly alkaline; gradual wavy boundary.

C1sa—16 to 29 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; massive; extremely hard, friable; visible calcium sulphate, calcium carbonate, and other salts; moderately calcareous; strongly alkaline; gradual wavy boundary.

C2sa—29 to 60 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; massive; extremely hard, friable; calcium sulphate, calcium carbonate, and other salts in the form of fine crystals and powder; strongly alkaline.

The solum is 10 to 20 inches thick. Calcareous material is at a depth of 0 to 4 inches.

The soil material in the lower part of the B horizon has a sodium adsorption ratio of more than 13. Reaction is strongly alkaline or very strongly alkaline.

The C horizon has a sodium adsorption ratio of more than 13.

Arvada series

The Arvada series consists of deep, well drained soils that are nearly level. These soils are on stream terraces and fans. They formed in clayey alluvium. Slope is 0 to 2 percent. The average annual precipitation is about 13 inches.

Typical pedon of Arvada clay is located in an area of Arvada-Absted clays, 0 to 2 percent slopes; 1,600 feet west and 300 feet south of the northeast corner of sec. 16, T. 18 S., R. 53 W., about 11 miles north of Arlington:

A2—0 to 1 inch; pale brown (10YR 6/3) loam, dark grayish brown (10YR 4/2) moist; massive; hard, very friable, slightly sticky and slightly plastic; slightly calcareous; moderately alkaline; abrupt smooth boundary.

B1—1 to 2 inches; brown (10YR 5/3) clay, dark grayish brown (10YR 4/2) moist; strong fine granular structure; loose, friable, sticky and plastic; moderately calcareous; strongly alkaline; abrupt wavy boundary.

B2t—2 to 5 inches; brown (10YR 5/3) clay, dark grayish brown (10YR 4/2) moist; moderate medium prismatic structure parting to strong very fine angular blocky; very hard, firm, sticky and plastic; few thin clay films on faces of peds; moderately calcareous; strongly alkaline; abrupt wavy boundary.

B3tcs—5 to 14 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate very fine angular blocky structure; very hard, firm, sticky and plastic; few thin clay films on faces of peds; few fine crystals of calcium sulphate; moderately calcareous; strongly alkaline; clear wavy boundary.

C1cs—14 to 29 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; very fine granular; loose, friable, sticky and plastic; many fine crystals of calcium sulphate; moderately calcareous; strongly alkaline; gradual wavy boundary.

C2—29 to 60 inches; pale brown (10YR 6/3) clay, brown (10YR 4/3) moist; massive; extremely hard, firm, sticky and plastic; few fine crystals of calcium sulphate; moderately calcareous; strongly alkaline.

The solum is 10 to 20 inches thick. Calcareous material is at a depth of 0 to 6 inches.

Reaction of the A2 horizon ranges from moderately alkaline to strongly alkaline.

The B horizon has a sodium adsorption ratio of more than 13. Reaction is strongly alkaline to very strongly alkaline.

The C horizon is typically clay or clay loam and is strongly alkaline or very strongly alkaline.

Baca series

The Baca series consists of deep, well drained soils that are on upland flats and in swales. These soils formed in loess. Slope is 0 to 1 percent. The average annual precipitation ranges from 14 to 16 inches.

Typical pedon of a Baca loam in an area of Baca-Wiley complex, 0 to 2 percent slopes, 1,120 feet west and 1,320 feet south of the northeast corner of sec. 17, T. 18 S., R. 51 W., about 2 miles north of Haswell:

Ap—0 to 4 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, friable, sticky and plastic; mildly alkaline; clear smooth boundary.

B21t—4 to 11 inches; brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong medium and fine angular blocky; hard, firm, very sticky and plastic; thin continuous clay films on faces of peds; mildly alkaline; abrupt smooth boundary.

B22tca—11 to 17 inches; pale brown (10YR 6/3) heavy silty clay loam, brown (10YR 5/3) moist; moderate medium and fine angular blocky structure; hard, firm, very sticky and plastic; calcium carbonate visible as many soft nodules and powder coatings; thin patchy clay films; moderately calcareous; moderately alkaline; clear smooth boundary.

B3ca—17 to 25 inches; very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) moist; weak fine angular blocky structure; slightly hard, friable, sticky and plastic; calcium carbonate visible as few soft nodules, as powder coatings, and in thin seams; moderately calcareous; moderately alkaline; clear smooth boundary.

C—25 to 60 inches; very pale brown (10YR 7/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly sticky and slightly plastic; calcium carbonate visible as thin seams and powder coatings; moderately calcareous; moderately alkaline.

The solum is 15 to 30 inches thick. Calcareous material is at a depth of 8 to 20 inches.

The Ap horizon commonly is clay loam or loam. It is mildly alkaline or moderately alkaline.

The B2t horizon is clay, clay loam, or heavy silty clay loam. It is 35 to 45 percent clay.

The C horizon commonly is silt loam, but it is light silty clay loam in some pedons.

Bankard series

The Bankard series consists of deep, somewhat excessively drained soils on terraces and flood plains. These soils formed in sandy alluvium. Slope is 0 to 1 percent. The average annual precipitation ranges from 13 to 16 inches.

Typical pedon of Bankard loamy fine sand in an area of Bankard-Glenberg complex, 1,800 feet west, 1,000 feet south of the northeast corner of sec. 18, T. 18 S., R. 45 W., about 4 miles north and 3 miles west of Brandon:

A1—0 to 4 inches; brown (10YR 5/3) loamy fine sand, dark brown (10YR 3/3) moist; weak fine granular structure; soft; moderately alkaline; clear wavy boundary.

C—4 to 60 inches; pale brown (10YR 6/3) stratified loamy sand and gravelly sand and thin lenses of brown (10YR 5/3) sandy loam dry, dark brown (10YR 4/3) and yellowish brown (10YR 5/4) moist; average texture is loamy sand; single grained; loose; slightly calcareous; moderately alkaline.

Calcareous material is at a depth of 0 to 6 inches.

The A horizon is loamy fine sand or light sandy loam. When moist, color ranges from brown to dark brown.

The C horizon is variable in texture because it is stratified. It ranges from gravelly sand to sandy loam that is slightly calcareous to moderately calcareous. Some of the thin strata, however, are noncalcareous.

The weighted average percentage of rock fragments is from 3 to 15 percent. In some pedons the C horizon is mottled in the lower part.

Bijou series

The Bijou series consists of deep, somewhat excessively drained soils that are level to gently sloping. These soils are on uplands in the sandhills. They formed in eolian material. Slope ranges from 0 to 4 percent. The average annual precipitation is 14 inches.

Typical pedon of Bijou loamy sand in an area of Bijou-Valent loamy sands, 1 to 8 percent slopes, 3,000 feet west of the northeast corner of sec. 13, T. 18 S R. 47 W., about 1 mile north and 8 miles east of Eads:

A1—0 to 7 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 4/3) moist; weak fine granular structure; soft, very friable; mildly alkaline; clear wavy boundary.

B1—7 to 9 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable, nonsticky and nonplastic; mildly alkaline; clear wavy boundary.

B2t—9 to 20 inches; dark brown (10YR 4/3) sandy loam, dark brown (10YR 3/3) moist; medium coarse prismatic structure parting to medium coarse subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; few thin clay films on ped surfaces and as bridges between sand grains; mildly alkaline; clear wavy boundary.

B3—20 to 24 inches; dark yellowish brown (10YR 4/4) sandy loam, dark yellowish brown (10YR 4/4) moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable, slightly sticky and nonplastic; neutral; clear wavy boundary.

C1—24 to 41 inches; yellowish brown (10YR 5/4) sand, yellowish brown (10YR 5/4) moist; massive parting to single grained; slightly hard, very friable; neutral; clear wavy boundary.

C2—41 to 60 inches; yellowish brown (10YR 5/4) sand, yellowish brown (10YR 5/4) moist; single grained; loose; mildly alkaline.

The solum ranges from 20 to 40 inches in thickness. Calcareous material is at a depth of 40 to 60 inches or more. The A horizon ranges in reaction from neutral to mildly alkaline. The C horizon ranges in texture from sand to loamy sand.

Cadoma series

The Cadoma series consists of moderately deep, well drained soils that are nearly level to moderately sloping. These soils are on upland plains. They formed in material weathered from clayey shale. Slope ranges from 1 to 8 percent. The average annual precipitation is about 13 inches.

Typical pedon of Cadoma clay, 1 to 8 percent slopes, 2,322 feet east and 30 feet south of the northwest corner of sec. 32, T. 18 S., R. 52 W. about 5 miles west of Haswell:

A1—0 to 4 inches; yellowish brown (10YR 5/4) clay, brown (10YR 5/3) moist; weak fine granular structure; hard, firm, sticky and plastic; moderately calcareous; moderately alkaline; clear smooth boundary.

B2—4 to 9 inches; yellowish brown (10YR 5/4) clay, brown (10YR 5/3) moist; moderate medium angular blocky structure; very hard, very friable, very sticky and very plastic; moderately calcareous; strongly alkaline; clear smooth boundary.

B3cs—9 to 14 inches; pale brown (10YR 6/3) clay loam, grayish brown (2.5Y 5/2) moist; moderate medium prismatic structure parting to weak medium blocky; very hard, very firm, sticky and plastic; calcium sulphate visible as many fine crystals and soft powdery nodules and in thin seams; moderately calcareous; moderately alkaline; gradual wavy boundary.

C1—14 to 22 inches; light yellowish brown (10YR 6/4) clay, grayish brown (2.5Y 5/2) moist; weak medium blocky structure; extremely hard, extremely firm, very sticky and very plastic; nests of large calcium sulphate crystals; slightly calcareous; moderately alkaline; gradual wavy boundary.

C2—22 to 34 inches; pale brown (10YR 6/3) clay; grayish brown (2.5Y 5/2) moist; massive; extremely hard, extremely firm, very sticky and very plastic; nests of large calcium sulphate crystals; slightly calcareous; moderately alkaline; gradual wavy boundary.

C3r—34 to 60 inches; variegated dark gray shale interbedded with calcium sulphate crystals.

The solum is 10 to 24 inches thick. It is typically calcareous throughout, but may be leached in the upper few inches in some pedons.

The A horizon has hue of 10YR or 2.5Y. Reaction is moderately alkaline to strongly alkaline.

The B2 horizon has hue of 10YR or 2.5Y. Reaction is moderately alkaline to very strongly alkaline.

The C horizon has hue of 10YR or 2.5Y. Reaction is moderately alkaline to very strongly alkaline. This horizon has a sodium adsorption ratio of more than 13.

Canyon series

The Canyon series consists of shallow, well drained soils that are gently sloping to moderately steep. These soils are on breaks and ridges in uplands. They formed in marl. Slope is 1 to 20 percent. The average annual precipitation ranges from 14 to 16 inches.

Typical pedon of Canyon gravelly loam in an area of Canyon-Rock outcrop complex, 1 to 20 percent slopes, 150 feet east of the southwest corner of sec. 24, T. 17 S., R. 42 W:

A1—0 to 4 inches; brown (10YR 5/3) gravelly loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, very friable, slightly sticky and slightly plastic; 20 percent angular pebbles that are mostly on the surface; strongly calcareous; moderately alkaline; clear wavy boundary.

AC—4 to 12 inches; very pale brown (10YR 7/3) heavy loam, light brownish gray (10YR 6/3) moist; massive; slightly hard, very friable, sticky and slightly plastic; calcium carbonate visible as soft nodules and powder coatings; strongly calcareous; moderately alkaline; clear irregular boundary.

C1—12 to 19 inches; white (10YR 8/2) heavy loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, very friable, sticky and slightly plastic; 10 percent limestone pebbles; calcium carbonate visible as continuous powder coating and soft nodules; very strongly calcareous; moderately alkaline; clear irregular boundary.

Cr—19 to 60 inches; highly fractured limestone in a marl matrix.

The solum is 6 to 12 inches thick. Partly consolidated bedrock is at a depth of 7 to 20 inches.

The A horizon is typically gravelly loam that is 5 to 40 percent gravel. Reaction ranges from mildly alkaline to moderately alkaline.

The C horizon ranges from loam to light clay loam. It is 0 to 15 percent rock fragments.

The underlying bedrock ranges from soft, powdery marl to a combination of marl and highly fractured limestone.

Colby series

The Colby series consists of deep, well drained soils that are nearly level to moderately sloping. These soils are on rolling upland plains. They formed in loess. Slope ranges from 1 to 9 percent. The average annual precipitaion ranges from 14 to 16 inches.

Typical pedon of Colby silt loam, 1 to 3 percent slopes, is located 800 feet east and 1,500 feet north of

the southwest corner of sec. 36, T. 18 S., R. 44 W., about 1.5 miles south of Sheridan Lake:

Ap—0 to 4 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) moist; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; moderately calcareous; moderately alkaline; clear smooth boundary.

AC—4 to 11 inches; very pale brown (10YR 7/4) silt loam, yellowish brown (10YR 5/4), moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; moderately calcareous; moderately alkaline; clear smooth boundary.

C—11 to 60 inches; very pale brown (10YR 7/3) silt loam, yellowish brown (10YR 5/4), moist; massive; soft, very friable, slightly sticky and nonplastic; moderately calcareous; moderately alkaline.

The solum ranges from 6 to 12 inches. Calcareous material is typically at the surface but may be leached from the upper few inches in some areas.

The A horizon is mildly alkaline to moderately alkaline. The C horizon is typically silt loam but is light silty clay loam in some pedons. Distinct horizons of visible calcium carbonate are common in the upper part of this horizon.

Fluvaquents

In this survey area Fluvaquents consist of deep, somewhat poorly drained and poorly drained soils that formed in mixed alluvium. The soils are on flood plains along Rush Creek and Big Sandy Creek. They are also mapped in areas adjacent to lakes, where seep water has affected the soils. Slope is 0 to 1 percent. The average annual precipitation is about 14 inches.

The reference pedon of Fluvaquents, nearly level, is located 1,600 feet west and 70 feet north of the southeast corner of sec. 30, T. 19 S., R. 45 W:

A1—0 to 5 inches; brown (10YR 5/3) clay loam, dark grayish brown (10YR 4/2), moist; moderate medium granular structure; hard, very friable, sticky and plastic; slightly calcareous; moderately alkaline; clear smooth boundary.

C1—5 to 14 inches; pale brown (10YR 6/3) loamy fine sand, brown (10YR 4/3) moist; few fine distinct yellowish brown (10YR 5/6) mottles, moist; single grained; loose; slightly calcareous; moderately alkaline; abrupt smooth boundary.

C2—14 to 18 inches; brown (10YR 5/3) clay, dark brown (10YR 3/3) moist; few fine distinct brownish yellow (10YR 6/8) mottles, moist; massive; very hard, firm, very sticky and very plastic; salts visible in thin seams; slightly calcareous; moderately alkaline; abrupt smooth boundary.

C3g—18 to 28 inches; very pale brown (10YR 7/3) sand, yellowish brown (10YR 5/4) moist; common, fine distinct brownish yellow (10YR 6/8) mottles, moist; single grained; loose; few small black coatings on sand grains; slightly calcareous; strongly alkaline; abrupt smooth boundary.

C4g—28 to 30 inches; light yellowish brown (10YR 6/4) clay loam, dark grayish brown (10YR 4/2) moist; common fine distinct yellowish brown (10YR 5/8) mottles, moist; very hard, firm, sticky and plastic; salts visible in thin seams; slightly calcareous; moderately alkaline; abrupt smooth boundary.

C5g—30 to 60 inches; light gray (10YR 7/2) gravelly sand, yellowish brown (10YR 5/4) moist; some dark staining on sand and gravel grains; single grained; moderately alkaline.

The water table ranges from a depth of 1 to 3 feet in the spring of most years. The surface layer ranges from sandy loam to clay loam. The subsurface layer is variable in texture and color.

Fort Collins series

The Fort Collins series consists of deep, well drained soils that are nearly level to gently sloping. These soils are on plains and in swales of uplands. They formed in mixed alluvial and eolian material. Slope is 0 to 3 percent. The mean annual precipitation ranges from 12 to 15 inches.

Typical pedon of Fort Collins sandy loam, 0 to 3 percent slopes, 170 feet west and 2,600 feet south of the northeast corner of sec. 16, T. 20 S., R. 54 W., about 6 miles west of Arlington:

Ap—0 to 6 inches; brown (10YR 5/3) sandy loam, dark brown (10YR 4/3) moist; weak fine granular structure; soft, friable, slightly sticky and slightly plastic; mildly alkaline; clear smooth boundary.

B2t—6 to 14 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; strong medium prismatic structure parting to strong medium and fine angular blocky; very hard, firm, sticky and plastic; thin continuous clay films on faces of peds; neutral; clear wavy boundary.

B3ca—14 to 26 inches; pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, friable, slightly sticky and slightly plastic; calcium carbonate visible as many soft nodules, as powder coatings, and in thin seams; moderately calcareous; moderately alkaline; clear wavy boundary.

C—26 to 60 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; massive; hard, very friable, slightly sticky and slightly plastic; calcium carbonate visible as few thin seams and powder coatings; moderately calcareous; strongly alkaline; clear smooth boundary.

The solum ranges from 15 to 30 inches in thickness. Carbonates are at a depth of 10 to 20 inches.

The A horizon ranges from mildly alkaline to moderately alkaline.

The B horizon is clay loam or heavy loam. In some pedons the upper part of this horizon may be sandy clay loam. Clay ranges from 25 to 35 percent. Reaction is neutral to moderately alkaline.

The C horizon is loam or clay loam. Reaction ranges from mildly alkaline to strongly alkaline.

Glenberg series

The Glenberg series consists of deep, well drained soils that are nearly level. These soils are on terraces and flood plains. They formed in sandy alluvium deposited by intermittent streams. Slope is 0 to 1 percent. The average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Glenberg fine sandy loam in an area of Bankard-Glenberg complex, 1,960 feet south and 2,000 feet west of the northeast corner of sec. 24, T. 19 S., R. 46 W., about 3 miles south and 1 mile east of Chivington:

A1—0 to 5 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse platy structure; slightly hard, very friable; slightly sticky and slightly plastic; slightly calcareous; moderately alkaline; abrupt smooth boundary.

C—5 to 60 inches; pale brown (10YR 6/3) sandy loam stratified with thin lenses of loamy sand to clay loam, brown (10YR 5/3) moist; typical texture is sandy loam; massive parting to single grained when crushed; slightly hard to hard, very friable, nonsticky and nonplastic; slightly calcareous; moderately alkaline.

The solum ranges from 3 to 12 inches in thickness. Calcareous material is typically at the surface or may be leached from the upper few inches.

The A horizon is mildly alkaline to moderately alkaline.

The C horizon is variable in texture, because it is stratified. Texture ranges from sand to clay loam. The typical texture is sandy loam. Weighted average percentage of rock fragments ranges from 0 to 15 percent. The C horizon is slightly calcareous to moderately calcareous; however some of the thin strata are commonly noncalcareous. Reaction ranges from moderately alkaline to strongly alkaline. In some pedons this horizon has mottles in the lower part.

Goshen series

The Goshen series consists of deep, well drained soils that are nearly level. These soils are in drainageways. They formed in alluvium. Slope is 0 to 1 percent. The average annual precipitation is about 17 inches.

Typical pedon of Goshen silt loam, 2,400 feet east and 1,500 feet south of the northwest corner of sec. 11, T. 19 S., R. 42 W., about 4 miles south of Towner:

A1—0 to 5 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable, sticky and plastic; neutral; clear smooth boundary.

B1t—5 to 20 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to very fine angular blocky; slightly hard, friable, sticky and plastic; few thin clay films on faces of peds; mildly alkaline; clear smooth boundary.

B21t—20 to 28 inches; dark grayish brown (10YR 4/2) silty clay loam, dark brown (10YR 3/3) moist; moderate medium prismatic structure parting to moderate fine angular blocky; hard, firm, sticky and plastic; few thin clay films on faces of peds; mildly alkaline; gradual smooth boundary.

B3t—28 to 36 inches; brown (10YR 5/3) silty clay loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to moderate fine angular blocky; hard, firm, sticky and plastic; few thin clay films on faces of peds; mildly alkaline; abrupt smooth boundary.

C—36 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; slightly hard, friable, sticky and plastic; calcium carbonate visible as few soft nodules, as powder coatings, and in thin seams; moderately calcareous; mildly alkaline.

The thickness of the mollic epipedon ranges from 20 to 40 inches. Thickness of solum and depth to calcareous material range from 32 to 60 inches.

The A horizon has granular or platy structure. Reaction is neutral to mildly alkaline.

The B horizon is silty clay loam or heavy silt loam. Clay ranges from 23 to 35 percent. Reaction is mildly alkaline or moderately alkaline.

The C horizon is silty clay loam, silt loam, or loam. Reaction is mildly alkaline to moderately alkaline.

Harvey series

The Harvey series consists of deep, well drained soils that are nearly level to gently sloping. These soils are on plains and side slopes in uplands. They formed in mixed, calcareous, loamy deposits that are both alluvial and eolian. Slope is 1 to 3 percent. The average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Harvey loam in an area of Kim-Harvey loams, 1 to 3 percent slopes, 75 feet south and 160 feet east of the northwest corner of sec. 18, T. 20 S., R. 54 W., about 8 miles west of Arlington:

Ap—0 to 5 inches; pale brown (10YR 6/3) loam, dark brown (10YR 4/3) moist; weak fine granular struc-

ture; slightly hard, very friable, slightly sticky and slightly plastic; moderately calcareous; mildly alkaline; clear smooth boundary.

B2ca—5 to 18 inches; light yellowish brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak coarse subangular blocky structure; slightly hard, friable, sticky and plastic; calcium carbonate visible as many soft nodules and powder coatings; moderately calcareous; moderately alkaline; clear smooth boundary.

C1ca—18 to 30 inches; white (10YR 8/2) loam, light gray (10YR 7/2) moist; massive; soft, very friable, slightly sticky and slightly plastic; calcium carbonate visible as many soft nodules and continuous powder coatings; strongly calcareous; moderately alkaline; gradual smooth boundary.

C2ca—30 to 50 inches; light yellowish brown (10YR 6/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; massive; slightly hard, friable, sticky and plastic; 5 percent fine pebbles; calcium carbonate visible as few soft nodules and powder coatings on pebbles, few fine crystals of calcium sulphate; moderately calcareous; mildly alkaline; clear wavy boundary.

IIC3—50 to 60 inches; light yellowish brown (10YR 6/4) gravelly sandy loam, yellowish brown (10YR 5/6) moist; massive; soft, very friable, slightly sticky and slightly plastic; 20 percent fine pebbles; calcium carbonate coatings on pebbles; slightly calcareous; mildly alkaline.

The upper boundary of the calcic horizon is at a depth of 7 to 24 inches.

The A horizon is mildly alkaline to moderately alkaline.

The B horizon ranges from loam to sandy clay loam.

The C horizon ranges from light clay loam to gravelly sandy loam. Reaction of the C horizon is mildly alkaline to moderately alkaline.

Haverson series

The Haverson series consists of deep, well drained soils that are nearly level. These soils are on flood plains and in drainageways. They formed in medium textured alluvium. Slope is 0 to 1 percent. The average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Haverson clay loam is 60 feet south and 0.3 mile east of the northwest corner of sec. 28, T. 18 S., R. 46 W., about 2 miles north and 2 miles west of Chivington:

A1—0 to 14 inches; grayish brown (10YR 5/2) clay loam, brown (10YR 4/3) moist; moderate medium granular structure; hard, firm, sticky and plastic; slightly calcareous; moderately alkaline; clear smooth boundary.

C1—14 to 23 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium and coarse angular blocky structure; slightly hard, friable, sticky and plastic; moderately calcareous; moderately alkaline; clear smooth boundary.

C2—23 to 30 inches; brown (10YR 5/3) sandy loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable, slightly sticky and nonplastic; moderately calcareous; moderately alkaline; clear smooth boundary.

C3—30 to 50 inches; pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; hard, very friable, slightly sticky and slightly plastic; calcium carbonate visible as few soft nodules and powder coatings; moderately calcareous; moderately alkaline; clear smooth boundary.

C4—50 to 60 inches; light brownish gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) moist; massive; extremely hard, firm, sticky and plastic; calcium carbonate visible as many soft nodules and powder coatings, calcium sulphate visible as fine crystals; moderately calcareous; moderately alkaline.

Calcareous material is typically at the surface but may be leached from the upper few inches of some pedons.

The A horizon is mildly alkaline to moderately alkaline. It is slightly calcareous to moderately calcareous.

The C horizon typically is loam or light clay loam but may have thin strata that range from loamy sand to clay. It is slightly calcareous to moderately calcareous.

Keyner series

The Keyner series consists of deep, well drained soils that are nearly level to gently sloping. These soils formed in mixed alluvium and eolian material. They formed in low lying areas in the sandhills. Slope is 0 to 3 percent. Average annual precipitation is about 15 inches.

Typical pedon of Keyner loamy sand, 0 to 2 percent slope, 1,500 feet west, 150 feet north of the southeast corner of sec. 18, T. 19 S., R. 45 W., about 3 miles south and 3 miles east of Chivington:

A1—0 to 11 inches; brown (10YR 5/3) loamy sand, dark yellowish brown (10YR 4/4) moist; single grained; loose; moderately alkaline; clear wavy boundary.

B2t—11 to 17 inches; brown (10YR 5/3) sandy clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium and fine angular blocky; hard, very friable, sticky and slightly plastic; many fine clay films on faces of peds; moderately alkaline; clear wavy boundary.

B3sacs—17 to 26 inches; light yellowish brown (10YR 6/4) heavy sandy loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; hard, very friable, sticky and slightly plastic; sodium salts, calcium carbonate, calcium sulphate and other salts visible in the form of many powder coatings and fine crystals; salt seams are effervescent, soil

matrix is noneffervescent; slightly calcareous; strongly alkaline; gradual wavy boundary.

Csacs—26 to 60 inches; light yellowish brown (10YR 6/4) heavy sandy loam, brown (10YR 5/3) moist; massive; hard, very friable, sticky and slightly plastic; calcium carbonate, calcium sulphate, and other salts in the form of small seams, powder coatings, and fine crystals; moderately calcareous; strongly alkaline.

The solum is 15 to 36 inches thick. Calcareous material is at a depth of 10 to 18 inches.

The A horizon ranges in reaction from mildly alkaline to moderately alkaline.

The B horizon is typically sandy clay loam, but in the lower part it may range to sandy loam. It has a clay content that ranges from 18 to 30 percent. The lower part of this horizon has a sodium adsorption ratio of more than 13. It ranges from moderately alkaline to very strongly alkaline.

The C horizon is moderately alkaline to very strongly alkaline.

Keyner Variant

The Keyner Variant consists of deep, well drained soils that are nearly level. These soils are on terraces. They formed in sandy alluvium and eolian material that was deposited over older clayey alluvium. Slope is 0 to 1 percent. Average annual precipitation is about 15 inches.

Typical pedon of Keyner Variant loamy sand, 750 feet east, 950 feet south of the northwest corner of sec. 1, T. 20 S., R. 46 W., about 6 miles south of Chivington:

A1—0 to 10 inches; brown (10YR 5/3) loamy sand, brown (10YR 4/3) moist; weak, very fine granular structure; loose, very friable; moderately alkaline; clear smooth boundary.

B21t—10 to 14 inches; yellowish brown (10YR 5/4) sandy loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, very friable, slightly sticky and slightly plastic; common thin clay films on faces of peds; slightly calcareous; moderately alkaline; clear wavy boundary.

B22tsa—14 to 24 inches; olive yellow (2.5Y 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, very friable, slightly sticky and slightly plastic; few thin clay films on faces of peds; salts visible as fine crystals and powder coatings in many thin seams; moderately calcareous; strongly alkaline; clear wavy boundary.

B3sa—24 to 29 inches; olive yellow (2.5Y 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak coarse prismatic structure parting to weak medium blocky; very hard, friable, sticky and plastic; calcium carbonate and other salts visible as powder coatings and fine crystals in thin seams and as soft nodules; moderately calcareous; strongly alkaline; clear wavy boundary.

C1—29 to 37 inches; olive yellow (2.5Y 6/4) clay loam, yellowish brown (10YR 5/4) moist; weak coarse prismatic structure; very hard, firm, sticky and plastic; calcium carbonate and other salts visible as few small spots; moderately calcareous; moderately alkaline; clear wavy boundary.

IIC2—37 to 60 inches; pale olive (5Y 6/3) clay, olive (5Y 5/3) moist; massive; extremely hard, very firm, very sticky and very plastic; calcium carbonate visible as many powder coatings, calcium sulphate and other salts visible as many small crystals; moderately calcareous; moderately alkaline.

Calcareous material is at a depth of 6 to 18 inches. The contrasting clay substratum is at a depth of 20 to 40 inches.

The A horizon ranges in reaction from mildly alkaline to moderately alkaline.

The B horizon is sandy loam, clay loam, or sandy clay loam that has a clay content of 18 to 35 percent. The lower part of this horizon has a sodium saturation ratio of 13 or more. The B horizon is moderately alkaline to strongly alkaline. It has hue of 10YR to 2.5Y.

The upper part of the C horizon is clay loam or sandy clay loam. Reaction ranges from moderately alkaline to strongly alkaline. The lower part of the C horizon is moderately alkaline or strongly alkaline. Color ranges in hue from 10YR through 5Y.

Kim series

The Kim series consists of deep, well drained soils that are nearly level to gently sloping. These soils are on upland plains. They formed in medium textured alluvium. Slope is 1 to 12 percent. Average annual precipitation ranges from 12 to 16 inches.

Typical pedon of Kim loam in an area of Kim-Stoneham-Larimer loams, 3 to 12 percent slopes, 1,400 feet south, 20 feet west of the northeast corner of sec. 28, T. 18 S., R. 48 W., about 1 mile south of Eads:

A1—0 to 4 inches; brown (10YR 5/3) loam, brown (10YR 4/3) moist; weak, fine granular structure; slightly hard, very friable, slightly sticky; moderately calcareous; moderately alkaline; clear wavy boundary.

AC—4 to 11 inches; yellowish brown (10YR 5/4) loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; calcium carbonate visible as powder coatings in few thin seams; moderately calcareous; moderately alkaline; clear wavy boundary.

C1ca—11 to 38 inches; light yellowish brown (10YR 6/4) sandy clay loam, yellowish brown (10YR 5/4) moist; massive; hard, very friable, sticky and slightly plastic;

calcium carbonate visible as many soft nodules, as powder coatings, and in small seams; moderately calcareous; moderately alkaline; gradual wavy boundary.

C2—38 to 60 inches; light yellowish brown (10YR 6/4) sandy loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, very friable, slightly sticky; moderately calcareous; moderately alkaline.

Calcareous material is typically at the surface but may be leached from the upper few inches in some areas.

The A horizon is slightly calcareous to moderately calcareous.

The C horizon is loam, clay loam, or sandy clay loam. It may be sandy loam in the lower part.

Larimer series

The Larimer series consists of deep, well drained soils that are gently sloping to moderately sloping. These soils are on upland side slopes. They formed in medium textured alluvium over coarse textured outwash. Slope is 3 to 10 percent. Average annual precipitation ranges from 12 to 16 inches.

Typical pedon of Larimer loam in an area of Kim-Stoneham-Larimer loams, 3 to 12 percent slope, 150 feet south of the northwest corner of sec. 27, T. 18 S., R. 48 W., about 1 mile south of Eads:

A1—0 to 3 inches; grayish brown (10YR 5/2) loam, brown (10YR 4/3) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; moderately alkaline; clear wavy boundary.

B2t—3 to 9 inches; dark yellowish brown (10YR 4/4) heavy loam, dark yellowish brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium blocky; hard, very friable, sticky and plastic; few medium thick films on faces of peds; moderately alkaline; clear wavy boundary.

B3ca—9 to 11 inches; yellowish brown (10YR 5/4) loam, brown (10YR 5/3) moist; weak medium prismatic structure parting to weak medium blocky; slightly hard, very friable, sticky and slightly plastic; calcium carbonate visible as few soft powdery nodules and in thin seams; moderately calcareous; moderately alkaline; clear wavy boundary.

C1ca—11 to 28 inches; very pale brown (10YR 7/3) light sandy clay loam, yellowish brown (10YR 5/4) moist; light yellowish brown (10YR 6/4) moist and crushed; massive; hard, very friable, sticky and slightly plastic; calcium carbonate visible as many soft powdery nodules and coatings; moderately calcareous; moderately alkaline; clear wavy boundary.

IIC2—28 to 60 inches; brownish yellow (10YR 6/6) very gravelly loamy sand, yellowish brown (10YR 5/6) moist; single grained; loose; 45 percent fine pebbles; moderately alkaline.

The solum ranges from 10 to 18 inches thick. Depth to the sand and gravel substratum ranges from 20 to 40 inches. Calcareous material is at a depth of 8 to 18 inches.

The B horizon is heavy loam or light clay loam. Reaction ranges from mildly to moderately alkaline.

The Cca horizon ranges from loam to light sandy clay loam.

Limon series

The Limon series consists of deep, well drained soils that are level. These soils are in drainageways and on flood plains. They formed in clayey alluvium washed from weathered shale. Slope is 0 to 1 percent. The average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Limon clay, 750 feet east and 140 feet south of the northwest corner of sec. 36, T. 18 S., R. 53 W., about 7 miles west of Haswell:

A1—0 to 6 inches; brown (10YR 5/3) clay, brown (10YR 4/3) moist; thin platy structure; slightly hard, friable, sticky and plastic; moderately calcareous; moderately alkaline; clear smooth boundary.

AC—6 to 16 inches; brown (10YR 5/3) clay, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, friable, very sticky and plastic; moderately calcareous; moderately alkaline; gradual wavy boundary.

C1—16 to 31 inches; brown (10YR 5/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable, very sticky and plastic; moderately calcareous; moderately alkaline; gradual wavy boundary.

C2—31 to 60 inches; brown (10YR 5/3) clay, brown (10YR 5/3) moist; massive; hard, firm, very sticky and plastic; moderately calcareous; strongly alkaline.

These soils typically are calcareous throughout. They crack during dry periods. Cracks are 1/2 inch to 2 inches wide and extend from the surface to a depth of 1 foot to 3 feet.

The A horizon is mildly alkaline to moderately alkaline.

The C horizon typically is clay loam, clay, or silty clay. Clay content ranges from 35 to 50 percent. In places this horizon is stratified with lenses of sandy loam.

Manzanola series

The Manzanola series consists of deep, well drained soils that are nearly level. These soils are in drainageways, on broad flats, and at the base of long slopes. They formed in fine textured alluvium. Slope is 0 to 2 percent. The average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Manzanola clay loam, 0 to 2 percent slopes, 1,500 feet south of the northeast corner of sec. 22, T. 19 S., R. 52 W., about 5 miles south and 2 miles west of Haswell:

Ap—0 to 6 inches; light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; hard, very friable, sticky and slightly plastic; slightly calcareous; moderately alkaline; clear smooth boundary.

B21t—6 to 12 inches; pale brown (10YR 6/3) clay loam, brown (10YR 4/3) moist; weak medium prismatic structure parting to moderate medium angular blocky; hard, very friable, sticky and plastic; common thin clay films on faces of peds; slightly calcareous; moderately alkaline; clear smooth boundary.

B22t—12 to 25 inches; light yellowish brown (10YR 6/4) clay, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, friable, sticky and plastic; common thin clay films on faces of peds; moderately calcareous; strongly alkaline; clear smooth boundary.

B3tcs—25 to 32 inches; light yellowish brown (10YR 6/4) clay loam, brown (10YR 5/3) moist; weak medium prismatic structure parting to weak medium angular blocky; hard, very friable, sticky and plastic; few thin clay films on faces of peds; calcium carbonate visible as many soft nodules and powder coatings, common fine crystals of calcium sulphate; moderately calcareous; strongly alkaline; clear smooth boundary.

Ccs—32 to 60 inches; light yellowish brown (10YR 6/4) clay loam, brown (10YR 5/3) moist; massive; hard, very friable, sticky and plastic; calcium carbonate visible as many soft nodules and powder coatings, common fine crystals of calcium sulphate; moderately calcareous; strongly alkaline; clear smooth boundary.

Calcareous material is at a depth of 0 to 8 inches. Continuous subhorizons of calcium carbonate or calcium sulphate or both are at a depth of 10 to 30 inches.

The B horizon is heavy clay loam or light clay. Reaction ranges from moderately alkaline to strongly alkaline.

The C horizon is clay loam or light clay. It ranges from moderately alkaline to strongly alkaline. This horizon typically has calcium sulphate crystals; but these crystals are not in some pedons.

Midway series

The Midway series consists of shallow, well drained soils that are moderately sloping to strongly sloping. These soils are on upland plains. They formed in gypsiferous clayey shale. Slope is 5 to 12 percent. The average annual precipitation is about 13 inches.

Typical pedon of Midway clay, 5 to 12 percent slopes, 500 feet south and 2,440 feet east of the northwest corner of sec. 32, T. 18 S., R. 52 W., about 5 miles west of Haswell:

A1—0 to 5 inches; light yellowish brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/4) moist; moderate very fine granular structure; hard, firm, very sticky and very plastic; many fine crystals of calcium sulphate; slightly calcareous; moderately alkaline; clear smooth boundary.

C1—5 to 10 inches; light yellowish brown (2.5Y 6/4) clay, light olive brown (2.5Y 5/6) moist; weak medium subangular blocky structure; very hard, very firm, very sticky and very plastic; 30 percent soft shale fragments; many fine crystals of calcium sulphate; slightly calcareous; moderately alkaline; clear smooth boundary.

C2r—10 to 60 inches; weathered shale that has seams of large calcium sulphate crystals.

The A and C horizons range from clay to silty clay loam. They are moderately alkaline to strongly alkaline and are slightly calcareous to moderately calcareous. The underlying bedrock is at a depth of 10 to 20 inches.

Norka series

The Norka series consists of deep, well drained soils that are nearly level. These soils are on uplands. They formed in loess. Slope is 0 to 2 percent. The average annual precipitation is 16 inches.

Typical pedon of Norka silt loam, 0 to 2 percent slopes, 1,600 feet north and 270 feet east of the southwest corner of sec. 23, T. 19 S., R. 43 W., about 5 miles south and 2 miles west of Plainview School:

Ap1—0 to 4 inches; brown (10YR 5/3) silt loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

Ap2—4 to 7 inches; dark brown (10YR 4/3) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

B21t—7 to 11 inches; brown (10YR 4/3) silty clay loam, brown (10YR 4/3) moist; strong medium prismatic structure parting to strong medium and fine blocky; hard, very friable, sticky and plastic; clay films on faces of peds; mildly alkaline; clear wavy boundary.

B22tca—11 to 14 inches; brown (10YR 5/3) silty clay loam, brown (10YR 5/3) moist; strong medium prismatic structure parting to strong fine blocky; hard, very friable, sticky and slightly plastic; calcium carbonate visible as few soft nodules and thin seams; moderately calcareous; moderately alkaline; clear wavy boundary.

B3ca—14 to 18 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to strong fine blocky; hard, very friable, sticky and slightly plastic; calcium

carbonate visible as many soft nodules, as powder coatings, and in thin seams; moderately calcareous; moderately alkaline; gradual wavy boundary.

C1ca—18 to 28 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; weak coarse prismatic structure; slightly hard, very friable, sticky and slightly plastic; calcium carbonate visible as common soft nodules, as powder coatings, and in thin seams; moderately calcareous; moderately alkaline; gradual wavy boundary.

C2—28 to 60 inches; very pale brown (10YR 7/3) silt loam, yellowish brown (10YR 5/3) moist; massive; soft, very friable; slightly sticky and slightly plastic; moderately calcareous; moderately alkaline.

The solum is 10 to 20 inches thick. Calcareous material commonly is at a depth of 5 to 14 inches, but the upper part of the Ap horizon is slightly calcareous in some pedons.

The A horizon is neutral or mildly alkaline.

The B horizon typically is silty clay loam, but clay content ranges from 25 to 35 percent.

Olney series

The Olney series consists of deep, well drained soils that are nearly level. These soils are on upland plains. They formed in eolian and alluvial material. Slope is 0 to 2 percent. The average annual precipitation is about 15 inches.

Typical pedon of Olney loamy sand, 0 to 2 percent slopes, 1,000 feet west, 100 feet south of the northeast corner of sec. 17, T. 20 S., R. 45 W., about 8 miles south and 3 miles west of Brandon:

A1—0 to 6 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) moist; weak fine granular structure; soft, very friable; mildly alkaline; clear smooth boundary.

B2t—6 to 19 inches; yellowish brown (10YR 5/4) light sandy clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate medium blocky; hard, very friable, sticky and slightly plastic; mildly alkaline; clear wavy boundary.

B3ca—19 to 27 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 4/3) moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; visible calcium carbonate visible as many soft nodules, as powder coatings, and in thin seams; moderately calcareous; moderately alkaline; clear wavy boundary.

Cca—27 to 60 inches; pale brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; calcium carbonate visible as few powdery coatings and in thin seams; moderately calcareous; moderately alkaline.

Calcareous material is at a depth of 15 to 28 inches. Depth of the solum ranges from 20 to 35 inches.

The B horizon is typically light sandy clay loam, but clay content ranges from 18 to 30 percent.

The C horizon is fine sandy loam or sandy loam.

Otero series

The Otero series consists of deep, well drained soils that are nearly level to gently sloping. These soils are on knolls shaped like dunes and on hillsides. They formed in medium textured alluvium. Slope is 1 to 5 percent. Average annual precipitation is about 13 inches.

Typical pedon of Otero sandy loam, 1 to 5 percent slopes, 1,000 feet east, 1,200 feet north of the southwest corner of sec. 8, T. 19 S., R. 51 W., about 9 miles south of Haswell:

Ap—0 to 2 inches; pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; weak very fine structure; soft, very friable, slightly sticky and slightly plastic; moderately calcareous; moderately alkaline; abrupt smooth boundary.

B2t—2 to 4 inches; dark yellowish brown (10YR 4/4) sandy loam, brown (10YR 4/3) moist; moderate medium subangular blocky structure; hard, very friable, slightly sticky and slightly plastic; clay bridging between sand grains; slightly calcareous; mildly alkaline; clear wavy boundary.

C1ca—4 to 14 inches; light yellowish brown (10YR 6/4) sandy loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; calcium carbonate visible as common powder coatings and in thin seams; moderately calcareous; moderately alkaline; clear wavy boundary.

C2ca—14 to 60 inches; very pale brown (10YR 7/3) sandy loam, light yellowish brown (10YR 4/4) moist; massive; slightly hard, slightly sticky and slightly plastic; calcium carbonate visible as few powdery coatings; moderately calcareous; moderately alkaline.

These soils are calcareous throughout, or they may be leached in the upper few inches in some areas that are less eroded.

The A horizon is slightly calcareous to moderately calcareous. In some areas, the B2t horizon is completely eroded.

Pultney series

The Pultney series consists of moderately deep, well drained soils that are gently sloping to moderately sloping. These soils are on upland side slopes. They formed in material weathered from gypsiferous shale. Slope is 2 to 10 percent. Mean annual precipitation ranges from 12 to 16 inches.

Typical pedon of Pultney clay loam in an area of Singerton-Pultney complex, 1 to 10 percent slopes, 800 feet north and 3,100 feet west of the southeast corner of sec. 28, T. 19 S., R. 52 W., about 5 miles south and 3 miles west of Haswell:

Ap—0 to 6 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; weak fine granular structure; slightly hard, very friable, sticky and plastic; strongly calcareous; moderately alkaline; clear smooth boundary.

ACcacs—6 to 15 inches; light yellowish brown (2.5Y 6/4) clay loam, light olive brown (2.5Y 5/4) moist; moderate medium prismatic structure parting to weak moderate subangular blocky; hard, friable, sticky and plastic; calcium carbonate visible as few powder coatings; strongly calcareous; moderately alkaline; gradual wavy boundary.

C1—15 to 25 inches; pale yellow (2.5Y 7/4) clay loam, light yellowish brown (2.5Y 6/3) moist; massive; hard, friable, sticky and plastic; 15 percent soft shale chips; calcium carbonate visible as many soft nodules and powder coatings, many fine crystals of calcium sulphate; strongly calcareous; moderately alkaline; gradual wavy boundary.

C2r—25 inches; buff, weathered calcareous gypsiferous shale.

Depth to bedrock ranges from 20 to 40 inches. The A horizon is moderately to strongly calcareous. The C horizon is typically clay loam, but noncarbonate clay ranges from 25 to 35 percent.

Richfield series

The Richfield series consists of deep, well drained soils that are nearly level. These soils are on flats and in depressions of uplands. They formed in loess. Slope is 0 to 1 percent. The average annual precipitation is about 17 inches.

Typical pedon of Richfield silt loam, 0 to 1 percent slopes, 60 feet south, 250 feet east of the northwest corner of sec. 23, T. 19 S., R. 43 W., about 5 miles south of Plainview School:

Ap—0 to 7 inches; brown (10YR 5/3) silt loam, very dark grayish brown (10YR 3/3) moist; moderate medium granular structure; soft, very friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

B21t—7 to 14 inches; brown (10YR 4/3) heavy silty clay loam, dark brown (10YR 3/3) moist; strong fine prismatic structure parting to strong fine blocky; hard, friable, sticky and plastic; many thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

B22t—14 to 18 inches; yellowish brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; strong medium prismatic structure parting to strong very fine blocky; hard, friable, sticky and plastic; many thin clay films on faces of peds; moderately alkaline; clear wavy boundary.

B3ca—18 to 22 inches; pale brown (10YR 6/3) light silty clay loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to moderate medium blocky; slightly hard, very friable, sticky and plastic; calcium carbonate visible as many soft nodules and powder coatings; moderately calcareous; moderately alkaline; clear wavy boundary.

C1ca—22 to 26 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist and crushed; weak coarse prismatic structure; slightly hard, very friable, sticky and slightly plastic; calcium carbonate visible as many soft nodules and powder coatings; moderately calcareous; moderately alkaline; gradual wavy boundary.

C2—26 to 60 inches; very pale brown (10YR 7/4) silt loam, pale brown (10YR 6/3) moist and crushed; massive; soft, very friable, slightly sticky and slightly plastic; moderately calcareous; strongly alkaline.

The solum ranges from 16 to 34 inches in thickness. Calcareous material is at a depth of 10 to 18 inches.

The B horizon is typically silty clay loam that is an average of 35 to 42 percent clay. Reaction is mildly alkaline to moderately alkaline.

The C horizon ranges from moderately alkaline to strongly alkaline.

Shingle series

The Shingle series consists of shallow, well drained soils that are gently to moderately sloping. These soils are on upland side slopes. They formed in material weathered from shale. Slope is 2 to 10 percent. The average annual precipitation is about 14 inches.

Typical pedon of Shingle clay loam, 2 to 10 percent slopes, 125 feet north, 2,000 feet west of the southeast corner of sec. 7, T. 19 S., R. 52 W., about 7 miles west and 3 miles south of Haswell.

A1—0 to 4 inches; yellow (2.5Y 7/6) clay loam, olive yellow (2.5Y 6/6) moist; weak moderate platy structure; slightly hard, friable, sticky and slightly plastic; calcium sulphate visible as few fine crystals; moderately calcareous; moderately alkaline; clear smooth boundary.

C1—4 to 16 inches; yellow (2.5Y 8/6) clay loam, olive yellow (2.5Y 6/6) moist; massive; slightly hard, friable, sticky and slightly plastic; soft shale fragments, as much as 50 percent in lower part; calcium sulphate visible as many fine crystals; strongly calcareous; moderately alkaline; gradual wavy boundary.

C2r—16 to 60 inches; soft, yellowish gypsiferous calcareous shale of the Niobrara Formation.

Depth to bedrock ranges from 10 to 20 inches.

The C horizon ranges from moderately to strongly alkaline. It is from 10 to 60 percent soft shale fragments. The percentage of fragments in the C horizon increases with depth. The C horizon ranges from moderately calcareous to strongly calcareous.

Singerton series

The Singerton series consists of deep, well drained soils that are nearly level to moderately sloping. These soils are on uplands. They formed in material weathered from gypsiferous shales. Slope is 0 to 8 percent. The average annual precipitation ranges from 12 to 16 inches.

Typical pedon of Singerton loam in an area of Singerton-Pultney complex, 1 to 10 percent slopes, 1,200 feet east of the southwest corner of sec. 10, T. 20 S., R. 52 W., about 9 miles south and 3 miles west of Haswell:

Ap—0 to 6 inches; light yellowish brown (2.5Y 6/4) loam, light olive brown (2.5Y 5/4) moist; moderate fine granular structure; slightly hard, very friable, sticky and slightly plastic; moderately calcareous; moderately alkaline; abrupt smooth boundary.

ACca—6 to 15 inches; pale yellow (2.5Y 7/4) clay loam, light yellowish brown (2.5Y 6/4) moist; moderate medium prismatic structure parting to weak moderate and fine subangular blocky; hard, friable, sticky and plastic; 5 percent fine pebbles; calcium carbonate visible in many thin streaks and as powder coatings, common fine crystals of calcium sulphate; strongly calcareous; moderately alkaline; clear wavy boundary.

C1ca—15 to 26 inches; pale yellow (2.5Y 7/4) clay loam, olive yellow (2.5Y 6/6) moist; massive; hard, friable, sticky and plastic; 5 percent fine pebbles; calcium carbonate and calcium sulphate visible as powder coatings and in fine crystals; strongly calcareous; moderately alkaline; clear wavy boundary.

C2ca—26 to 35 inches; pale yellow (2.5Y 7/4) clay loam, olive yellow (2.5Y 6/6) moist; massive; hard, friable, sticky and plastic; 5 percent fine pebbles; calcium carbonate visible as many thin seams and as powder coatings, many fine crystals of calcium sulphate; very strongly calcareous; moderately alkaline; clear wavy boundary.

C3—35 to 60 inches; pale yellow (2.5Y 7/4) clay loam, olive yellow (2.5Y 6/6) moist; massive; hard, friable, sticky and plastic; 10 percent fine gravel and shale chips; calcium sulphate visible as many fine and medium crystals; strongly calcareous; moderately alkaline.

A calcic horizon ranges in depth from 6 to 25 inches. The A and AC horizons have hues of 10YR or 2.5Y and are moderately calcareous to strongly calcareous. The C horizon has hue of 10YR or 2.5Y. Calcium carbonate and calcium sulphate make up about 40 to 60 percent of the soil material. More than 65 percent of the carbonates and gypsum are calcium carbonate. The percentage of calcium carbonate decreases and increases sporadically with depth. Discontinuous layers of calcium sulphate crystals are in some pedons. The C horizon is from 0 to 15 percent coarse fragments. Reaction is moderately alkaline to strongly alkaline.

Stoneham series

The Stoneham series consists of deep, well drained soils that are nearly level to gently sloping. These soils are on upland plains. They formed in mixed alluvial and eolian material. Slope is 0 to 5 percent. Average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Stoneham loam, 0 to 3 percent slopes, 1,500 feet east and 200 feet north of the southwest corner of sec. 31, T. 20 S., R. 54 W., about 4 miles south and 8 miles west of Arlington:

Ap—0 to 4 inches; brown (10YR 5/3) loam, brown (10YR 4/3) moist; weak fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; slightly calcareous; moderately alkaline; clear smooth boundary.

B2t—4 to 8 inches; brown (10YR 5/3) clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, friable, sticky and plastic; few thin clay films on faces of peds; slightly calcareous; moderately alkaline; clear wavy boundary.

B3ca—8 to 13 inches; pale brown (10YR 6/3) light clay loam, yellowish brown (10YR 5/4) moist; moderate medium prismatic structure parting to moderate medium blocky; hard, friable, sticky and plastic; calcium carbonate visible as many soft nodules and powder coatings; moderately calcareous; moderately alkaline; clear wavy boundary.

C1ca—13 to 19 inches; pale brown (10YR 6/3) loam, yellowish brown (10YR 5/4) moist; weak medium prismatic structure parting to weak medium blocky; hard, friable, sticky and plastic; calcium carbonate visible as many soft nodules and powder coatings; moderately calcareous; moderately alkaline; clear wavy boundary.

C2ca—19 to 26 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; weak coarse prismatic structure parting to weak medium blocky; hard, friable, sticky and plastic; calcium carbonate visible as many powder coatings and in thin seams; moderately calcareous; moderately alkaline; gradual wavy boundary.

C3—26 to 40 inches; very pale brown (10YR 8/3) light clay loam, brownish yellow (10YR 6/6) moist; massive; slightly hard, very friable, sticky and slightly plastic; moderately calcareous; moderately alkaline.

The solum ranges from 10 to 15 inches in thickness. Calcareous material is typically at a depth of 3 to 10 inches; however, in some eroded areas calcareous material is at the surface.

The A horizon is loam or sandy loam. It ranges in reaction from mildly alkaline to moderately alkaline.

The B horizon is a heavy loam or a light clay loam. Reaction ranges from mildly alkaline to moderately alkaline.

The C horizon ranges from loam to light clay loam.

Sundance series

The Sundance series consists of deep well drained soils that are nearly level. These soils are on upland plains. They formed in eolian sand over loess. Slope is 0 to 2 percent. The average annual precipitation is about 15 inches.

Typical pedon of Sundance loamy sand, 700 feet west and 2,580 feet south of the northeast corner of sec. 3, T. 19 S., R. 47 W., about 3 miles south and 7 miles east of Eads:

Ap—0 to 8 inches; yellowish brown (10YR 5/4) loamy sand, dark brown (10YR 4/3) moist; single grained; loose; neutral; abrupt smooth boundary.

B21t—8 to 17 inches; dark yellowish brown (10YR 4/4) sandy loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; few thin clay films on faces of peds; neutral; abrupt smooth boundary.

IIB22tb—17 to 28 inches; yellowish brown (10YR 5/4) clay loam, brown (10YR 4/3) moist; moderate medium prismatic structure parting to strong medium angular blocky; slightly hard, very friable, sticky and plastic; common thin clay films on faces of peds; neutral; gradual wavy boundary.

IIB3cab—28 to 45 inches; very pale brown (10YR 7/3) silt loam, light yellowish brown (10YR 6/4) moist; moderate medium angular blocky structure; soft, very friable, sticky and plastic; calcium carbonate visible as common soft nodules and powder coatings; moderately calcareous; moderately alkaline; clear wavy boundary.

IICb—45 to 60 inches; very pale brown (10YR 7/4) silt loam, light yellowish brown (10YR 6/4) moist; massive; soft, very friable, slightly sticky and slightly plastic; calcium carbonate visible as few thin seams; moderately calcareous; moderately alkaline.

A buried soil is at a depth of 10 to 30 inches. Calcareous material is at a depth of 15 to 30 inches.

The B21t horizon is sandy loam or light sandy clay loam.

The IIB2tb horizon is clay loam or silty clay loam that is 27 to 35 percent clay.

Valent series

The Valent series consists of deep, somewhat excessively drained soils that are gently sloping to moderately sloping. These soils are on ridges shaped like dunes in the sandhills. They formed in eolian sand. Slope is 2 to 10 percent. The average annual precipitation is about 14 inches.

Typical pedon of Valent loamy sand, 3 to 10 percent slopes, 1,145 feet north, 135 feet west of the southeast corner of sec. 21, T. 18 S., R. 46 W., about 2 miles north and 1 mile west of Chivington:

A1—0 to 5 inches; brown (10YR 5/3) loamy sand, dark brown (10YR 3/3) moist; weak fine granular and single grained; loose; mildly alkaline; clear wavy boundary.

AC—5 to 17 inches; yellowish brown (10YR 5/4) sand, dark yellowish brown (10YR 4/4) moist; massive parting to single grained when crushed; soft, loose; mildly alkaline; gradual wavy boundary.

C—17 to 60 inches; light yellowish brown (10YR 6/4) sand, yellowish brown (10YR 5/4) moist; single grained; loose; neutral.

Calcareous material is at a depth of 40 to 60 inches or more.

The A horizon is typically loamy sand but may be sand in some places. Reaction ranges from neutral to mildly alkaline.

The AC horizon is sand or loamy sand that is massive, single grained, or has a weak, coarse, prismatic structure.

The C horizon ranges from neutral to mildly alkaline.

Vona series

The Vona series consists of deep, well drained soils that are nearly level to moderately sloping. These soils are on upland plains and slopes. They formed in mixed, eolian material. Slope is 1 to 10 percent. Average annual precipitation ranges from 12 to 15 inches.

Typical pedon of Vona sandy loam in an area of Vona-Stoneham sandy loams, 1 to 10 percent slopes, 1,800 feet east, 850 feet south of the northwest corner of sec. 20, T. 20 S., R. 51 W., about 9 miles south of Haswell:

Ap—0 to 4 inches; brown (10YR 5/3) sandy loam; brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; mildly alkaline; abrupt smooth boundary.

B2t—4 to 8 inches; dark yellowish brown (10YR 4/4) sandy loam, brown (10YR 4/3) moist; moderate coarse subangular blocky structure; hard, very friable, sticky and slightly plastic; clay bridging between sand grains; mildly alkaline; clear wavy boundary.

B3ca—8 to 16 inches; brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; weak coarse subangular blocky structure; slightly hard, very friable; sticky and slightly plastic; calcium carbonate visible as many powder coatings; moderately calcareous; moderately alkaline; clear wavy boundary.

C1ca—16 to 39 inches; brown (10YR 5/3) sandy loam, brown (10YR 4/3) moist; massive; soft, very friable, slightly sticky and nonplastic; calcium carbonate visible as common powder coatings and in thin seams; moderately calcareous; moderately alkaline; gradual wavy boundary.

C2—39 to 60 inches; very pale brown (10YR 7/4) loamy sand, light yellowish brown (10YR 6/4) moist; massive parting to single grained when crushed; soft, very friable; slightly calcareous; moderately alkaline.

The solum ranges from 15 to 30 inches thick. Calcareous material is at a depth of 8 to 24 inches.

The A horizon ranges from neutral to mildly alkaline.

The B2t horizon has an average clay content of 10 to 18 percent. Reaction is neutral to mildly alkaline.

The C horizon is typically sandy loam, but in some pedons it is loamy sand.

Wiley series

The Wiley series consists of deep, well drained soils that are nearly level to gently sloping. These soils are on upland plains. They formed in loess. Slope is 0 to 3 percent. The average annual precipitation is 13 to 16 inches.

Typical pedon of a Wiley silt loam in an area of Baca-Wiley complex, 0 to 2 percent slopes, 1,800 feet south and 750 feet east of the northwest corner of sec. 15, T. 18 S., R. 49 W., about 6 miles west of Eads:

Ap—0 to 5 inches; brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; weak fine granular structure; soft, very friable, sticky and slightly plastic; moderately calcareous; moderately alkaline; clear smooth boundary.

B21t—5 to 11 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to strong fine angular blocky; hard, friable, sticky and plastic; few thin clay films on faces of peds; moderately calcareous; moderately alkaline; clear smooth boundary.

B22tca—11 to 16 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate medium prismatic structure parting to moderate medium angular blocky; slightly hard, friable; few thin clay films on faces of peds; moderately calcareous; calcium carbonate visible as few powdery coatings; moderately alkaline; clear smooth boundary.

B3ca—16 to 30 inches; pale brown (10YR 6/3) silt loam, pale brown (10YR 6/3) moist; weak coarse prismatic structure; slightly hard, friable, sticky and slightly plastic; calcium carbonate visible as many soft nodules and powder coatings; moderately calcareous; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; pale brown (10YR 6/3) silt loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, friable, sticky and slightly plastic; moderately calcareous; moderately alkaline.

The solum is 12 to 30 inches thick. Calcareous material ranges in depth from 0 to 7 inches.

The A horizon typically is loam or silt loam. It is mildly alkaline to moderately alkaline.

The B2t horizon typically is silty clay loam, but in some pedons the upper part is silt loam or loam. It is from 18 to 35 percent clay. In places, the upper part is slightly calcareous.

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to "Soil taxonomy" (*6*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 15, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Aridisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Argid (*Arg*, meaning Argillic horizon plus *id*, from Aridisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Haplargid (*Hapl*, meaning

minimum horizons, plus *argid*, the suborder of Aridisols that have an argillic horizon).

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great group, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Ustollic* identifies the subgroup as those soils that have more organic matter than the Typic concept. An example is Ustollic Haplargid.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine-silty, mixed, mesic, Ustollic Haplargid.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Formation of the soils

This section describes the factors of soil formation, relates them to the formation of soils in the area, and explains the processes of soil formation.

Soil is formed by the action of soil-forming processes on parent material that was deposited or accumulated by geologic forces. The characteristics of the soil are determined by the interaction of five factors of soil formation. Each of these factors modifies the effect of the others. The five interacting factors are: (1) the physical and mineralogical composition of the parent material; (2) the climate under which the parent material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time these forces have acted on the parent material. All five of these factors are important, but, in different locations and under different conditions, some are more effective than others. In places where any one factor varies widely, different soils are formed. The five main factors of soil formation are discussed in the following paragraphs.

Parent material

Parent material has a strong influence on the soils in Kiowa County and on the land use. Parent material significantly influences the chemical properties of the soil, as well as determining such physical characteristics as texture, color, consistence, and erodibility.

Alluvial parent materials.—Alluvium is material that has been transported and deposited by water. It is on recent flood plains and bottom lands, where additional soil material is deposited during flooding. In the western part of the county, along Mustang and Adobe Creeks, the parent material is influenced by shales. These parent materials give rise to soils that are saline and sodic and have high clay content. These soils generally do not have the stratification that typifies alluvial soils. Soils on older terraces have developed argillic horizons denoting rather long periods of stability. Absted, Limon, and Arvada soils are examples. Along Rush Creek and Big Sandy Creek, the sediment sources are in areas of sandstone lithology. These soils are typically stratified, sandy in nature, and have less clay than soils in drainage areas other than these two creeks. Bankard, Glenberg, and Haverson soils and Fluvaquents are examples of alluvial soils in these drainage areas.

Parent materials of eolian sand deposits.—These parent materials typically parallel Rush Creek and Big Sandy Creek. This indicates that the sandy sediments in these creeks had become windblown in the geologic past and were deposited over an older soil. The deposits consist of noncalcareous medium and fine sands, which have formed into Valent and Bijou soils. These soils have very rapid intake of water and rapid permeability. They produce abundant forage for livestock, but generally are too susceptible to blowing to be farmed successfully.

Parent materials weathered from shales.—In Kiowa County, two shale formations are of Cretaceous age; the Pierre Shale and shales of the Niobrara Formation. The Pierre Formation weathers to parent materials that are gray and have a high clay content. The soils formed from these parent materials are typically high in sodium salts and other salts. The parent materials from the Niobrara Formation are yellowish in color and have excessive amounts of calcium carbonate and calcium sulphate. The soils formed from shaley parent materials are generally not suited to farming because of chemical problems inherent in the shale. Typical soils of shale-derived parent material are Cadoma, Midway, Singerton, Shingle, and Pultney soils.

Parent material from loess.—These materials are calcareous and dominated by particles the size of silt. They were deposited by wind during the Quaternary Period and cover much of the Cretaceous Shales and Pleistocene Outwash Deposits. Typical soils formed in this mantle are Wiley, Colby, Norka and Richfield soils.

Parent material from loamy, mixed material.—This material is on pediments and in places where loess has been reworked by water and wind. Soils commonly formed from this type of parent material are Stoneham, Fort Collins, and Kim soils.

Climate

The climate in Kiowa County has had an effect on soil formation by influencing the physical and chemical weathering of parent materials. The climatic influence, however, has not significantly altered the dominating influence of parent material. The most pronounced effect of climate has been its effect upon vegetation. In most years, precipitation is insufficent to moisten the soil below a depth of a few feet. This severely limits both chemical and physical weathering in lower horizons. The limited moisture retards the leaching of soluble salts and freezing and thawing, which has a direct effect on soil formation. Such factors as low humidity and high wind velocity decrease plant growth and contribute to erosion and to the immaturity of soils.

Plant and animal life

Plants, micro-organisms, earthworms, and burrowing animals, as well as man, influence the development of soils. The types of plant cover and animal life are determined mainly by climatic factors and chemical characteristics of the soil. The soils in Kiowa County have developed under grass.

The native vegetation in Kiowa County is mainly short grasses, except on sandhills, where there are taller grasses. The root system of most perennial grasses is renewed every three years. This process has contributed to an accumulation of organic matter in the upper part of the soil. The native grasses typically have a shallow root system because moisture does not penetrate deeply.

Micro-organisms change organic matter into humus and aid in the release of nutrients needed for plant growth.

Prairie dogs, gophers, and badgers bring up soil material from deeper horizons and aid in mixing the soil. Earthworms feed on organic matter and help mix soil material. Worm casts increase the fertility of soil.

Modern man has been present for only a short period; however, his influence has been drastic. One severe windstorm can remove organic matter from an unprotected field, which has taken years to accumulate. Much of the soil that has been farmed in Kiowa County has undergone moderate to severe erosion.

Relief

Relief affects the formation of soils by its influence on runoff and erosion and by its modifying effect on climate. Other factors being equal, relief plays an important part in the formation of soils. Convex slopes have a more rapid rate of runoff and are more susceptible to downslope movement of soil by erosion and creep. Also, hilltops are exposed to higher wind velocities; therefore, they are susceptible to moisture losses because of evaporation. The soils on convex ridges are dryer, have been leached less, and have less organic matter than soils on more nearly flat slopes. Colby and Kim soils are examples of soils formed on convex slopes.

Soils that are level have less runoff and generally have developed a B horizon. Stoneham and Wiley soils are examples.

Soils formed where slopes are concave receive water from adjacent uplands. The soils in these areas are more deeply leached and have a well developed B horizon. Typically concave soils are Baca and Goshen soils.

Time

Long periods of time are required for the formation of soil. Other factors, such as climate and parent material, however, can influence the time required for a specific soil to form.

The time factor is indicated by the degree of soil formation rather than by the length of time the soil has been in place. For example, youthful soils do not have distinct genetic horizons, which are exhibited in a more mature soil. Hundreds, or perhaps thousands, of years are required for development of a B horizon. Also, the accumulation of organic matter in the surface layer requires a long time.

It is common in Kiowa County for parent materials of the same age to produce soils of different degrees of maturity. An example would be Wiley and Colby soils. Soils that have convex slopes are relatively immature because geologic erosion has kept pace with soil formation. Alluvial soils are relatively young because they receive additional material during flooding. Most soils on normal uplands are mature and have developed a B horizon.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on a contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Bottom land. The normal flood plain of a stream, subject to frequent flooding.

Broad-base terrace. A ridge-type terrace built to control erosion by diverting runoff along the contour at a nonscouring velocity. The terrace is 10 to 20 inches high and 15 to 30 feet wide and has gently sloping sides, a rounded crown, and a dish-shaped channel along the upper side. It may be nearly level or have a grade toward one or both ends.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catch crop. A crop planted to protect the soil from blowing.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Coarse textured (light textured) soil. Sand or loamy sand.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Complex, soil. A map unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave. Unstable walls of cuts made by earth-moving equipment. The soil sloughs easily.

Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some

are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Erosion pavement. A layer of gravel or stones that remains on the ground surface after fine particles are removed by wind or water. Desert pavements result from wind erosion in arid areas.

Excess alkali. Excess exchangeable sodium. The resulting poor physical properties restrict the growth of plants.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime. Excess carbonates. Excessive carbonates, or lime, restrict the growth of some plants.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured (heavy textured) soil. Sandy clay, silty clay, and clay.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather

conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material from 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Green manure (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table, which is the upper limit of saturation.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Gypsum. Hydrous calcium sulphate.

Habitat. The natural abode of a plant or animal; refers to the kind of environment in which a plant or animal normally lives, as opposed to the range or geographical distribution.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having

a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Leaching. The removal of soluble material from soil or other material by percolating water.

Light textured soil. Sand and loamy sand.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Lister furrowing. A system of furrowing with a lister crosswise to the prevailing wind direction to retain moisture and to help control soil blowing or washing.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material mixed with mineral soil material. The content of organic matter is more than 20 percent.

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Narrow-base terrace. A terrace no more than 4 to 8 feet wide at the base. A narrow-base terrace is similar to a broad-base terrace, except for the width of the ridge and channel.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms.

Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch), *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water of subsurface tunnels or pipelike cavities in the soil.

Pitting. Making shallow pits of suitable capacity and distribution to retain water from rainfall or snowmelt on rangeland or pasture.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Polypedon. A volume of soil having properties within the limits of a soil series, the lowest and most homogeneous category of soil taxonomy. A "soil individual."

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulates over disintegrating rock.

Rill. A steep sided channel resulting from accelerated erosion. A *rill* is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; contains harmful salts and is strongly alkaline; or contains harmful salts and exchangeable sodium and is very strongly alkaline. The salts, exchangeable sodium, and alkaline reaction are in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silica-alumina ratio. The molecular ratio of silica to alumina in soil, clay, or any alumino-silicate mineral.

Silica-sesquioxide ratio. The ratio of the number of molecules of silica to the number of molecules of alumina and iron oxide. The more highly weathered soils or their clay fractions in warm-temperate, humid regions, and especially those in the tropics, generally have a low ratio.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium absorption ratio (SAR) of a saturation extract, or the ratio of Na^+ to Ca^{++} plus Mg^{++}. The degrees of sodicity are—

	SAR
Slight	Less than 13:1
Moderate	13-30:1
Strong	More than 30:1

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil blowing hazard. The susceptibility of the soil to erosion by wind.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very*

coarse sand (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.005 to 0.002 millimeter); and *clay* (less than 0.002 millimeter).

Solodized soil. A formerly alkali (sodic) soil that has been leached so that it has become acid and has a thick, gray upper layer over an acid, blocky B horizon. The resulting soil may be termed a Soloth.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stratified. Arranged in strata, or layers. The term refers to geologic material. Layers in soils that result from the processes of soil formation are called horizons; those inherited from the parent material are called strata.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitaion is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Sweeps. A triangular shaped cultivator blade with a curved face that cuts off plants under the soil surface.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Trace elements. The chemical elements in soils, in only extremely small amounts, essential to plant growth. Examples are zinc, cobalt, manganese, copper, and iron.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Unstable fill. Risk of caving or sloughing in banks of fill material.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but the limited geographic soil area does not justify creation of a new series.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Waterspreading. The application of water to lands for the purpose of increasing the growth of natural vegetation or to store it in the ground for subsequent withdrawal by pumps for irrigation.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wetting depth. Depth to which a soil is wetted by normal precipitation.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

[Recorded in the period 1951 to 1973 at Eads, Colorado]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average daily	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	45.2	14.5	29.9	72	-14	0	0.20	0.00	0.48	1	4.1
February---	50.3	19.1	34.7	76	-5	14	0.33	0.00	0.57	1	4.4
March------	56.1	23.9	40.0	82	-1	38	0.69	0.09	1.15	2	5.2
April------	68.1	34.9	51.5	89	16	118	1.06	0.20	1.74	3	2.7
May--------	77.3	45.5	61.4	96	26	359	2.43	1.44	3.30	5	.6
June-------	88.0	55.3	71.6	106	40	648	1.97	0.55	3.11	4	.0
July-------	92.7	60.8	76.7	106	49	828	2.28	0.83	3.44	5	.0
August-----	90.5	58.7	74.6	103	46	763	1.92	0.55	3.01	3	.0
September--	82.4	49.1	65.7	99	32	471	1.20	0.26	1.94	2	.0
October----	71.4	37.3	54.4	91	17	191	0.89	0.00	1.53	2	1.7
November---	55.3	24.2	39.8	78	1	11	0.60	0.10	0.99	2	4.6
December---	46.6	16.8	31.7	74	-9	6	0.35	0.00	0.62	1	4.1
Year-------	68.7	36.7	52.7	106	-16	3,447	14.00	10.25	17.50	31	27.4

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951 to 1973 at Eads, Colorado]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	May 1	May 4	May 12
2 years in 10 later than--	April 25	April 29	May 2
5 years in 10 later than--	April 13	April 20	May 9
First freezing temperature in fall:			
1 year in 10 earlier than--	October 12	October 5	September 21
2 years in 10 earlier than--	October 17	October 10	September 27
5 years in 10 earlier than--	October 27	October 20	October 8

TABLE 3.--GROWING SEASON

[Recorded in the period 1951 to 1973 at Eads, Colorado]

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	169	164	135
8 years in 10	178	170	143
5 years in 10	195	183	158
2 years in 10	213	195	173
1 year in 10	222	201	181

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
1	Absted clay, 0 to 1 percent slopes	31,350	2.7
2	Arvada-Absted clays, 0 to 2 percent slopes	5,876	0.5
3	Baca loam, 0 to 1 percent slopes	18,472	1.6
4	Baca-Wiley complex, 0 to 2 percent slopes	137,876	12.0
5	Bankard-Glenberg complex	5,433	0.5
6	Bijou loamy sand, 0 to 2 percent slopes	11,308	1.0
7	Bijou-Valent loamy sands, 1 to 8 percent slopes	67,610	5.9
8	Cadoma clay, 1 to 8 percent slopes	11,671	1.0
9	Canyon-Rock outcrop complex, 1 to 20 percent slopes	845	0.1
10	Colby silt loam, 1 to 3 percent slopes	51,552	4.5
11	Colby silt loam, 3 to 9 percent slopes	10,222	0.9
12	Fluvaquents, nearly level	5,030	0.4
13	Fort Collins sandy loam, 0 to 3 percent slopes	84,673	7.4
14	Goshen silt loam	9,256	0.8
15	Haverson clay loam	5,272	0.5
16	Haverson clay loam, saline	3,541	0.3
17	Keyner loamy sand, 0 to 2 percent slopes	2,736	0.2
18	Keyner Variant loamy sand	1,851	0.2
19	Kim-Canyon complex, 2 to 10 percent slopes	1,207	0.1
20	Kim-Harvey loams, 1 to 3 percent slopes	11,027	1.0
21	Kim-Harvey-Stoneham loams, 1 to 3 percent slopes	21,852	1.9
22	Kim-Stoneham-Larimer loams, 3 to 12 percent slopes	23,905	2.1
23	Limon clay	12,677	1.1
24	Manzanola clay loam, 0 to 2 percent slopes	25,635	2.2
25	Midway clay, 5 to 12 percent slopes	2,495	0.2
26	Norka silt loam, 0 to 2 percent slopes	91,796	8.0
27	Olney loamy sand, 0 to 2 percent slopes	14,890	1.3
28	Otero sandy loam, 1 to 5 percent slopes	2,254	0.2
29	Playas	6,358	0.6
30	Richfield silt loam, 0 to 1 percent slopes	55,496	4.8
31	Shingle clay loam, 2 to 10 percent slopes	2,294	0.2
32	Singerton-Pultney complex, 1 to 10 percent slopes	29,096	2.5
33	Stoneham loam, 0 to 3 percent slopes	83,063	7.2
34	Stoneham-Kim loams, 0 to 2 percent slopes, eroded	17,506	1.5
35	Sundance loamy sand	12,918	1.1
36	Sundance-Fort Collins complex, 0 to 2 percent slopes	10,383	0.9
37	Valent loamy sand, 3 to 10 percent slopes	50,063	4.4
38	Valent-Blownout land complex, 2 to 8 percent slopes	10,785	0.9
39	Vona sandy loam, 1 to 3 percent slopes	7,606	0.7
40	Vona-Stoneham sandy loams, 1 to 10 percent slopes	14,971	1.3
41	Wiley loam	165,248	14.4
	Water	10,061	0.9
	Total	1,148,160	100.0

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields in the N columns are for nonirrigated soils; those in the I columns are for irrigated soils. Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Wheat		Grain sorghum	
	N	I	N	I
	Bu	Bu	Bu	Bu
3----------------------- Baca	25	60	20	100
4----------------------- Baca-Wiley	18	60	15	90
5----------------------- Bankard-Glenberg	---	37	---	55
6----------------------- Bijou	---	---	35	90
10---------------------- Colby	10	55	10	90
12*. Fluvaquents				
13---------------------- Fort Collins	20	55	22	90
14---------------------- Goshen	32	60	35	105
15---------------------- Haverson	12	50	12	90
16---------------------- Haverson	---	35	---	---
21---------------------- Kim-Harvey-Stoneham	12	60	10	90
23---------------------- Limon	---	50	---	60
24---------------------- Manzanola	12	55	12	80
26---------------------- Norka	22	60	20	100
27---------------------- Olney	20	55	35	100
30---------------------- Richfield	25	60	25	100
33---------------------- Stoneham	18	55	18	90
34---------------------- Stoneham-Kim	10	55	10	90
35---------------------- Sundance	20	50	40	100
36---------------------- Sundance-Fort Collins	25	55	30	90

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Wheat		Grain sorghum	
	N	I	N	I
	Bu	Bu	Bu	Bu
39 Vona	12	45	20	75
41 Wiley	18	60	15	85

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

[Only the soils that support rangeland vegetation suitable for grazing are listed]

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Compo- sition
			Lb/acre		Pct
1 Absted	Saline Overflow	Favorable	1,800	Alkali sacaton	50
		Normal	1,200	Blue grama	20
		Unfavorable	600	Western wheatgrass	10
				Galleta	5
				Buffalograss	5
				Fourwing saltbush	5
2*:					
Arvada	Salt Flat	Favorable	650	Alkali sacaton	30
		Normal	500	Blue grama	15
		Unfavorable	250	Galleta	10
				Western wheatgrass	10
				Nuttall alkaligrass	10
				Fourwing saltbush	10
				Inland saltgrass	5
				Bottlebrush squirreltail	5
Absted	Saline Overflow	Favorable	1,800	Alkali sacaton	50
		Normal	1,200	Blue grama	20
		Unfavorable	600	Western wheatgrass	10
				Galleta	5
				Buffalograss	5
				Fourwing saltbush	5
3 Baca	Loamy Plains	Favorable	1,800	Blue grama	50
		Normal	1,200	Western wheatgrass	15
		Unfavorable	800	Galleta	10
				Bottlebrush squirreltail	5
				Buffalograss	5
				Sedge	5
4*:					
Baca	Loamy Plains	Favorable	1,800	Blue grama	60
		Normal	750	Galleta	10
		Unfavorable	300	Western wheatgrass	10
				Buffalograss	5
				Red threeawn	5
				Bottlebrush squirreltail	5
Wiley	Loamy Plains	Favorable	1,000	Blue grama	60
		Normal	800	Galleta	10
		Unfavorable	400	Western wheatgrass	5
				Sideoats grama	5
				Sand dropseed	5
				Buffalograss	5
5*:					
Bankard	Sandy Bottomland	Favorable	1,500	Prairie sandreed	15
		Normal	1,200	Sand dropseed	15
		Unfavorable	800	Blue grama	15
				Switchgrass	10
				Sand bluestem	10
				Sand sagebrush	10
				Needleandthread	10
				Western wheatgrass	5
Glenberg	Sandy Bottomland	Favorable	2,000	Blue grama	20
		Normal	1,600	Prairie sandreed	15
		Unfavorable	800	Sand dropseed	10
				Needlegrass	10
				Switchgrass	10
				Sand bluestem	10
				Sand sagebrush	5
				Thickspike wheatgrass	5
				Canada wildrye	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
6 Bijou	Deep Sand	Favorable	2,000	Prairie sandreed	20
		Normal	1,600	Blue grama	15
		Unfavorable	800	Sand bluestem	10
				Sand dropseed	10
				Sand sagebrush	10
				Needleandthread	5
				Little bluestem	5
				Sideoats grama	5
				Thickspike wheatgrass	5
7*:					
Bijou	Deep Sand	Favorable	2,000	Prairie sandreed	20
		Normal	1,600	Blue grama	15
		Unfavorable	800	Sand bluestem	10
				Sand dropseed	10
				Sand sagebrush	10
				Needleandthread	5
				Little bluestem	5
				Sideoats grama	5
				Thickspike wheatgrass	5
Valent	Deep Sand	Favorable	2,000	Prairie sandreed	15
		Normal	1,200	Sand bluestem	15
		Unfavorable	800	Sand sagebrush	15
				Sand dropseed	10
				Blue grama	10
				Little bluestem	5
				Sideoats grama	5
				Sandhill muhly	5
				Needlegrass	5
				Indian ricegrass	5
				Switchgrass	5
				Thickspike wheatgrass	5
8 Cadoma	Alkaline Plains	Favorable	1,000	Alkali sacaton	40
		Normal	800	Blue grama	20
		Unfavorable	300	Galleta	15
				Fourwing saltbush	5
				Western wheatgrass	5
9*:					
Canyon	Gravel Breaks	Favorable	1,000	Little bluestem	25
		Normal	800	Sideoats grama	25
		Unfavorable	400	Blue grama	25
				Threadleaf sedge	5
				Needleandthread	5
				Western wheatgrass	5
Rock outcrop.					
10, 11 Colby	Loamy Plains	Favorable	1,100	Blue grama	65
		Normal	700	Sideoats grama	10
		Unfavorable	300	Buffalograss	5
				Western wheatgrass	5
				Sand dropseed	5
13 Fort Collins	Sandy Plains	Favorable	1,500	Blue grama	45
		Normal	1,100	Sideoats grama	15
		Unfavorable	600	Western wheatgrass	13
				Sand dropseed	10
				Needleandthread	5
				Low rabbitbrush	5
14 Goshen	Overflow	Favorable	2,500	Blue grama	50
		Normal	1,500	Western wheatgrass	30
		Unfavorable	800	Buffalograss	10

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
15 Haverson	Overflow	Favorable	1,500	Blue grama	45
		Normal	1,200	Western wheatgrass	10
		Unfavorable	800	Buffalograss	5
				Prairie junegrass	5
				Needlegrass	5
				Sedge	5
				Alkali sacaton	5
				Switchgrass	5
				Inland saltgrass	5
16 Haverson	Saline Overflow	Favorable	1,800	Alkali sacaton	50
		Normal	1,200	Blue grama	25
		Unfavorable	600	Inland saltgrass	10
				Galleta	5
				Sedge	5
				Western wheatgrass	5
17 Keyner	Sandy Salt Flat	Favorable	1,600	Alkali sacaton	50
		Normal	1,000	Blue grama	15
		Unfavorable	700	Inland saltgrass	15
				Western wheatgrass	10
				Buffalograss	5
				Sand sagebrush	5
18 Keyner Variant	Sandy Salt Flat	Favorable	1,600	Alkali sacaton	40
		Normal	1,000	Inland saltgrass	15
		Unfavorable	700	Blue grama	15
				Western wheatgrass	10
				Sand dropseed	5
				Sand sagebrush	5
				Switchgrass	5
19*:					
Kim	Loamy Plains	Favorable	1,100	Blue grama	50
		Normal	700	Western wheatgrass	15
		Unfavorable	300	Sand dropseed	10
				Sideoats grama	10
				Galleta	5
Canyon	Gravel Breaks	Favorable	1,100	Little bluestem	25
		Normal	800	Sideoats grama	25
		Unfavorable	400	Blue grama	25
				Threadleaf sedge	5
				Needleandthread	5
20*:					
Kim	Loamy Plains	Favorable	1,100	Blue grama	50
		Normal	700	Western wheatgrass	15
		Unfavorable	300	Sand dropseed	10
				Sideoats grama	10
				Galleta	5
Harvey	Loamy Plains	Favorable	1,100	Blue grama	65
		Normal	700	Sideoats grama	10
		Unfavorable	300	Sand dropseed	10
				Western wheatgrass	5
				Galleta	5
21*:					
Kim	Loamy Plains	Favorable	1,100	Blue grama	50
		Normal	700	Western wheatgrass	15
		Unfavorable	300	Sand dropseed	10
				Sideoats grama	10
				Galleta	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
21*:					
Harvey	Loamy Plains	Favorable	1,100	Blue grama	65
		Normal	700	Sideoats grama	10
		Unfavorable	300	Sand dropseed	10
				Western wheatgrass	5
				Galleta	5
Stoneham	Loamy Plains	Favorable	1,300	Blue grama	60
		Normal	800	Western wheatgrass	10
		Unfavorable	500	Buffalograss	10
				Sand dropseed	5
				Sideoats grama	5
				Needleandthread	5
22*:					
Kim	Loamy Plains	Favorable	1,100	Blue grama	50
		Normal	700	Western wheatgrass	15
		Unfavorable	300	Sand dropseed	10
				Sideoats grama	10
				Galleta	5
Stoneham	Loamy Plains	Favorable	1,300	Blue grama	60
		Normal	800	Western wheatgrass	10
		Unfavorable	500	Buffalograss	10
				Sand dropseed	5
				Sideoats grama	5
				Needleandthread	5
Larimer	Loamy Plains	Favorable	1,200	Blue grama	50
		Normal	800	Western wheatgrass	10
		Unfavorable	500	Buffalograss	5
				Needleandthread	5
				Bottlebrush squirreltail	5
				Sand dropseed	5
23 Limon	Saline Overflow	Favorable	2,000	Alkali sacaton	45
		Normal	1,500	Western wheatgrass	15
		Unfavorable	800	Blue grama	15
				Buffalograss	5
				Galleta	5
				Inland saltgrass	5
24 Manzanola	Saline Overflow	Favorable	1,500	Blue grama	40
		Normal	1,000	Alkali sacaton	25
		Unfavorable	500	Galleta	10
				Western wheatgrass	10
				Buffalograss	5
				Fourwing saltbush	5
25 Midway	Shaley Plains	Favorable	700	Alkali sacaton	50
		Normal	400	Blue grama	20
		Unfavorable	300	Galleta	15
				Western wheatgrass	5
				Sideoats grama	5
26 Norka	Loamy Plains	Favorable	2,000	Blue grama	50
		Normal	1,200	Western wheatgrass	15
		Unfavorable	800	Buffalograss	10
				Sedge	5
27 Olney	Sandy Plains	Favorable	1,800	Blue grama	25
		Normal	1,500	Needlegrass	10
		Unfavorable	1,000	Sand dropseed	10
				Prairie sandreed	10
				Sideoats grama	5
				Little bluestem	5
				Red threeawn	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
28 Otero	Sandy Plains	Favorable	1,200	Blue grama	40
		Normal	1,000	Sand dropseed	20
		Unfavorable	800	Galleta	10
				Sideoats grama	5
				Needlegrass	5
				Sand sagebrush	5
30 Richfield	Loamy Plains	Favorable	2,000	Blue grama	50
		Normal	1,400	Western wheatgrass	20
		Unfavorable	800	Buffalograss	10
				Little bluestem	5
				Junegrass	5
31 Shingle	Shaley Plains	Favorable	900	Alkali sacaton	40
		Normal	500	Blue grama	30
		Unfavorable	300	Sideoats grama	15
				Galleta	10
				Western wheatgrass	5
32*:					
Singerton	Loamy Plains	Favorable	1,000	Blue grama	50
		Normal	800	Galleta	10
		Unfavorable	300	Sideoats grama	10
				Winterfat	10
				Sand dropseed	5
				Western wheatgrass	5
Pultney	Alkaline Plains	Favorable	900	Alkali sacaton	30
		Normal	700	Blue grama	30
		Unfavorable	300	Galleta	15
				Western wheatgrass	5
				Fourwing saltbush	5
				Winterfat	5
33 Stoneham	Loamy Plains	Favorable	1,600	Blue grama	55
		Normal	1,200	Buffalograss	12
		Unfavorable	900	Western wheatgrass	8
				Sand dropseed	5
				Sideoats grama	5
				Sedge	5
34*:					
Stoneham	Loamy Plains	Favorable	1,300	Blue grama	60
		Normal	800	Western wheatgrass	10
		Unfavorable	500	Buffalograss	10
				Sand dropseed	5
				Sideoats grama	5
				Needleandthread	5
Kim	Loamy Plains	Favorable	1,100	Blue grama	50
		Normal	700	Western wheatgrass	15
		Unfavorable	300	Sand dropseed	10
				Sideoats grama	10
				Galleta	5
35 Sundance	Sandy Plains	Favorable	1,800	Prairie sandreed	25
		Normal	1,600	Blue grama	15
		Unfavorable	800	Sand dropseed	10
				Little bluestem	10
				Sideoats grama	10
				Needleandthread	5
				Sand sagebrush	5
				Thickspike wheatgrass	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production		Characteristic vegetation	Compo- sition
		Kind of year	Dry weight		
			Lb/acre		Pct
36*:					
Sundance	Sandy Plains	Favorable	1,800	Prairie sandreed	25
		Normal	1,600	Blue grama	15
		Unfavorable	800	Sand dropseed	10
				Little bluestem	10
				Sideoats grama	10
				Needleandthread	5
				Sand sagebrush	5
				Thickspike wheatgrass	5
Fort Collins	Sandy Plains	Favorable	1,500	Blue grama	45
		Normal	1,100	Sideoats grama	15
		Unfavorable	600	Western wheatgrass	13
				Sand dropseed	10
				Needleandthread	5
				Low rabbitbrush	5
37 Valent	Deep Sand	Favorable	2,000	Prairie sandreed	15
		Normal	1,200	Sand bluestem	15
		Unfavorable	800	Sand sagebrush	15
				Sand dropseed	10
				Blue grama	10
				Little bluestem	5
				Sideoats grama	5
				Sandhill muhly	5
				Needlegrass	5
				Indian ricegrass	5
				Switchgrass	5
				Thickspike wheatgrass	5
38*:					
Valent	Deep Sand	Favorable	2,000	Prairie sandreed	15
		Normal	1,200	Sand bluestem	15
		Unfavorable	800	Sand sagebrush	15
				Sand dropseed	10
				Blue grama	10
				Little bluestem	5
				Sideoats grama	5
				Sandhill muhly	5
				Needlegrass	5
				Indian ricegrass	5
				Switchgrass	5
				Thickspike wheatgrass	5
Blownout land.					
39 Vona	Sandy Plains	Favorable	1,500	Blue grama	40
		Normal	1,100	Sideoats grama	20
		Unfavorable	600	Sand dropseed	10
				Little bluestem	5
				Prairie sandreed	5
				Sedge	5
				Thickspike wheatgrass	5
40*:					
Vona	Sandy Plains	Favorable	1,500	Blue grama	40
		Normal	1,100	Sideoats grama	20
		Unfavorable	600	Sand dropseed	10
				Little bluestem	5
				Prairie sandreed	5
				Sedge	5
				Thickspike wheatgrass	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site name	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
40*:					
Stoneham	Loamy Plains	Favorable	1,600	Blue grama	55
		Normal	1,200	Buffalograss	10
		Unfavorable	900	Western wheatgrass	8
				Sand dropseed	5
				Sideoats grama	5
				Sedge	5
41 Wiley	Loamy Plains	Favorable	1,000	Blue grama	60
		Normal	800	Galleta	10
		Unfavorable	400	Western wheatgrass	5
				Sideoats grama	5
				Sand dropseed	5
				Buffalograss	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
1: Absted	Moderate: too clayey.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, shrink-swell.
2*:					
Arvada	Moderate: too clayey.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, shrink-swell.
Absted	Moderate: too clayey.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: low strength, shrink-swell.
3: Baca	Slight	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
4*:					
Baca	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Wiley	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
5*:					
Bankard	Severe: cutbanks cave, floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Glenberg	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
6: Bijou	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
7*:					
Bijou	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Valent	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
8: Cadoma	Moderate: too clayey, depth to rock.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
9*:					
Canyon	Severe: depth to rock.	Moderate: depth to rock, slope.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope.
Rock outcrop.					
10: Colby	Slight	Slight	Slight	Slight	Moderate: low strength.
11: Colby	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.
12*. Fluvaquents					
13: Fort Collins	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
14---------------- Goshen	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, low strength.
15---------------- Haverson	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
16---------------- Haverson	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
17---------------- Keyner	Slight-----------	Slight-----------	Slight-----------	Slight------------	Moderate: low strength, shrink-swell.
18---------------- Keyner Variant	Moderate: too clayey.	Severe: shrink-swell, floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, floods.	Severe: shrink-swell, low strength.
19*:					
Kim--------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.
Canyon-----------	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Moderate: depth to rock.
20*:					
Kim--------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Harvey-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
21*:					
Kim--------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Harvey-----------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
Stoneham---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
22*:					
Kim--------------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.
Stoneham---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.
Larimer----------	Severe: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Moderate: shrink-swell.
23---------------- Limon	Severe: floods.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, shrink-swell.	Severe: floods, low strength, shrink-swell.
24---------------- Manzanola	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
25 Midway	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Severe: low strength, shrink-swell.
26 Norka	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.
27 Olney	Slight	Slight	Slight	Slight	Moderate: low strength.
28 Otero	Slight	Slight	Slight	Slight	Slight.
29*. Playas					
30 Richfield	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
31 Shingle	Severe: depth to rock.	Moderate: depth to rock.	Severe: depth to rock.	Moderate: slope, depth to rock.	Moderate: depth to rock.
32*: Singerton	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.
Pultney	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Poor: low strength.
33 Stoneham	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
34*: Stoneham	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Kim	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
35 Sundance	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
36*: Sundance	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Fort Collins	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength, shrink-swell.
37 Valent	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
38*: Valent	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Blownout land.					
39 Vona	Slight	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 7.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
40*:					
Vona-------------	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Slight.
Stoneham---------	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
41--------------- Wiley	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1 Absted	Severe: percs slowly.	Slight	Severe: too clayey.	Moderate: floods.	Poor: too clayey, area reclaim.
2*:					
Arvada	Severe: percs slowly.	Slight	Severe: too clayey.	Moderate: floods.	Poor: too clayey, area reclaim.
Absted	Severe: percs slowly.	Slight	Severe: too clayey.	Moderate: floods.	Poor: too clayey, area reclaim.
3 Baca	Severe: percs slowly.	Slight	Moderate: floods, too clayey.	Moderate: floods.	Good.
4*:					
Baca	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Wiley	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Good.
5*:					
Bankard	Severe: floods.	Severe: floods, seepage.	Severe: floods, seepage.	Severe: floods, seepage.	Poor: too sandy.
Glenberg	Severe: floods.	Severe: floods, seepage.	Severe: seepage, floods.	Severe: floods, seepage.	Good.
6 Bijou	Slight	Severe: seepage.	Slight	Slight	Fair: too sandy.
7*:					
Bijou	Slight	Severe: seepage.	Slight	Slight	Fair: too sandy.
Valent	Slight	Severe: seepage.	Severe: too sandy.	Slight	Poor: too sandy.
8 Cadoma	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Slight	Poor: too clayey, area reclaim, excess salt.
9*:					
Canyon	Severe: depth to rock.	Severe: depth to rock, slope, seepage.	Severe: depth to rock.	Severe: depth to rock.	Poor: thin layer, area reclaim.
Rock outcrop.					
10, 11 Colby	Slight	Moderate: slope, seepage.	Slight	Slight	Good.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
12*. Fluvaquents					
13----------------- Fort Collins	Moderate: percs slowly.	Moderate: seepage.	Slight-----------	Slight-----------	Good.
14----------------- Goshen	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
15----------------- Haverson	Moderate: floods, percs slowly.	Severe: floods.	Moderate: floods.	Moderate: floods.	Good.
16----------------- Haverson	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Good.
17----------------- Keyner	Slight-----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
18----------------- Keyner Variant	Severe: percs slowly.	Severe: floods.	Severe: too clayey.	Moderate: floods.	Poor: too clayey.
19*:					
Kim---------------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
Canyon------------	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock.	Severe: depth to rock.	Poor: thin layer, area reclaim.
20*:					
Kim---------------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
Harvey------------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
21*:					
Kim---------------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
Harvey------------	Moderate: percs slowly.	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
Stoneham----------	Moderate: percs slowly.	Moderate: seepage.	Slight-----------	Slight-----------	Good.
22*:					
Kim---------------	Moderate: percs slowly.	Severe: slope.	Slight-----------	Slight-----------	Good.
Stoneham----------	Moderate: percs slowly.	Moderate: seepage.	Slight-----------	Slight-----------	Good.
Larimer-----------	Slight-----------	Severe: seepage.	Severe: too sandy.	Slight-----------	Poor: small stones.
23----------------- Limon	Severe: floods, percs slowly.	Severe: floods.	Severe: floods, too clayey.	Severe: floods.	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
24 Manzanola	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
25 Midway	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, too clayey.	Moderate: slope.	Poor: thin layer.
26 Norka	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
27 Olney	Slight	Severe: seepage.	Slight	Slight	Good.
28 Otero	Slight	Severe: seepage.	Slight	Slight	Good.
29*. Playas					
30 Richfield	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
31 Shingle	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: thin layer.
32*:					
Singerton	Moderate: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Pultney	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: thin layer.
33 Stoneham	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
34*:					
Stoneham	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
Kim	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
35 Sundance	Severe: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
36*:					
Sundance	Severe: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
Fort Collins	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
37 Valent	Slight	Severe: seepage.	Severe: too sandy.	Slight	Poor: too sandy.
38*:					
Valent	Slight	Severe: seepage.	Severe: too sandy.	Slight	Poor: too sandy.
Blownout land.					
39 Vona	Slight	Severe: seepage.	Slight	Slight	Good.

See footnote at end of table.

TABLE 8.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
40*:					
Vona	Slight	Severe: seepage.	Slight	Slight	Good.
Stoneham	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
41 Wiley	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and "poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1 Absted	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, excess salt, excess sodium.
2*:				
Arvada	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: excess sodium, excess salt, too clayey.
Absted	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, excess salt, excess sodium.
3 Baca	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
4*:				
Baca	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Wiley	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
5*:				
Bankard	Good	Fair: excess fines.	Fair: excess fines.	Poor: too sandy.
Glenberg	Good	Poor: excess fines.	Unsuited: excess fines.	Good.
6 Bijou	Good	Poor: excess fines.	Unsuited: exess fines.	Fair: too sandy.
7*:				
Bijou	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy.
Valent	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
8 Cadoma	Poor: low strength, shrink-swell, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, excess salt.
9*:				
Canyon	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Rock outcrop.				
10, 11 Colby	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
12*. Fluvaquents				

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
13 Fort Collins	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
14 Goshen	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
15 Haverson	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
16 Haverson	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines	Fair: excess salt.
17 Keyner	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Poor: excess sodium.
18 Keyner Variant	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: excess salt, excess sodium.
19*:				
Kim	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Canyon	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
20*:				
Kim	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Harvey	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
21*:				
Kim	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Harvey	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Stoneham	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: small stones.
22*:				
Kim	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Stoneham	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: small stones.
Larimer	Good	Poor: excess fines, small stones.	Good	Fair: small stones.
23 Limon	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
24 Manzanola	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
25-------------------- Midway	Poor: low strength, thin layer, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, too clayey.
26-------------------- Norka	Fair: low strength, frost action.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
27-------------------- Olney	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy.
28-------------------- Otero	Good-----------------	Poor: excess fines.	Unsuited: excess fines.	Good.
29*. Playas				
30-------------------- Richfield	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
31-------------------- Shingle	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
32*:				
Singerton------------	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, excess salt, small stones.
Pultney--------------	Poor: thin layer, area reclaim, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: excess salt.
33-------------------- Stoneham	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: small stones.
34*:				
Stoneham-------------	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: small stones.
Kim------------------	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
35-------------------- Sundance	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too sandy.
36*:				
Sundance-------------	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too sandy.
Fort Collins---------	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
37-------------------- Valent	Good-----------------	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
38*:				
Valent---------------	Good-----------------	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
Blownout land.				
39-------------------- Vona	Good-----------------	Poor: excess fines.	Unsuited: excess fines.	Good.

See footnote at end of table.

TABLE 9.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
40*:				
Vona	Good	Poor: excess fines.	Unsuited: excess fines.	Good.
Stoneham	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: small stones.
41 Wiley	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
1 Absted	Favorable	Hard to pack, excess sodium, excess salt.	Percs slowly, excess salt, excess sodium.	Slow intake, excess salt, excess sodium.	Percs slowly	Excess salt, excess sodium, percs slowly.
2*: Arvada	Favorable	Hard to pack, excess sodium.	Percs slowly	Excess salt, excess sodium, percs slowly.	Percs slowly	Excess salt, excess sodium.
Absted	Favorable	Hard to pack, excess sodium, excess salt.	Percs slowly, excess salt, excess sodium.	Slow intake, excess salt, excess sodium.	Percs slowly	Excess salt, excess sodium, percs slowly.
3 Baca	Seepage	Favorable	Favorable	Favorable	Favorable	Favorable.
4*: Baca	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable.
Wiley	Seepage	Piping	Favorable	Erodes easily	Favorable	Erodes easily.
5*: Bankard	Seepage	Seepage	Floods	Droughty, floods, fast intake.	Too sandy, soil blowing.	Droughty.
Glenberg	Seepage	Piping	Floods	Soil blowing	Soil blowing	Soil blowing.
6 Bijou	Seepage	Seepage, piping.	Favorable	Droughty, soil blowing.	Soil blowing	Droughty.
7*: Bijou	Seepage	Seepage, piping.	Favorable	Droughty, soil blowing.	Soil blowing	Droughty.
Valent	Slope, seepage.	Piping	Slope	Slope, soil blowing, droughty.	Soil blowing	Droughty.
8 Cadoma	Depth to rock	Hard to pack, thin layer, excess salt.	Percs slowly, depth to rock, excess salt.	Slow intake, rooting depth, excess salt.	Percs slowly, excess salt.	Excess salt, rooting depth, percs slowly.
9*: Canyon	Depth to rock, slope.	Thin layer	Not needed	Rooting depth, droughty, slope.	Depth to rock	Droughty, slope, rooting depth.
Rock outcrop.						
10 Colby	Seepage	Piping	Not needed	Erodes easily	Erodes easily	Erodes easily.
11 Colby	Slope, seepage.	Piping	Not needed	Slope, erodes easily.	Erodes easily	Erodes easily.
12*. Fluvaquents						
13 Fort Collins	Seepage	Favorable	Percs slowly	Favorable	Favorable	Favorable.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
14----------------- Goshen	Seepage--------	Favorable------	Not needed-----	Floods---------	Erodes easily	Erodes easily.
15----------------- Haverson	Seepage--------	Piping---------	Floods---------	Floods---------	Favorable------	Favorable.
16----------------- Haverson	Seepage--------	Piping---------	Floods---------	Floods, excess salt.	Favorable------	Favorable.
17----------------- Keyner	Seepage--------	Favorable------	Percs slowly, excess sodium, excess salt.	Excess sodium, percs slowly.	Soil blowing, too sandy.	Excess sodium, droughty.
18----------------- Keyner Variant	Favorable------	Excess salt, hard to pack.	Percs slowly, excess salt, excess sodium.	Excess sodium, percs slowly, droughty.	Too sandy, soil blowing, percs slowly.	Droughty, percs slowly, excess salt.
19*:						
Kim---------------	Seepage, slope.	Favorable------	Slope----------	Slope----------	Favorable------	Favorable.
Canyon------------	Depth to rock, slope.	Thin layer-----	Not needed-----	Rooting depth, droughty, slope.	Depth to rock	Droughty, rooting depth.
20*:						
Kim---------------	Seepage, slope.	Favorable------	Slope----------	Slope----------	Favorable------	Favorable.
Harvey------------	Seepage--------	Seepage--------	Slope----------	Erodes easily, slope.	Slope----------	Erodes easily, slope.
21*:						
Kim---------------	Seepage, slope.	Favorable------	Slope----------	Slope----------	Favorable------	Favorable.
Harvey------------	Seepage--------	Seepage--------	Slope----------	Erodes easily, slope.	Favorable------	Erodes easily.
Stoneham----------	Seepage--------	Favorable------	Favorable------	Favorable------	Favorable------	Favorable.
22*:						
Kim---------------	Seepage, slope.	Favorable------	Slope----------	Slope----------	Favorable------	Favorable.
Stoneham----------	Seepage--------	Favorable------	Favorable------	Favorable------	Favorable------	Favorable.
Larimer-----------	Slope, seepage.	Seepage--------	Slope----------	Slope, droughty.	Favorable------	Droughty.
23----------------- Limon	Favorable------	Hard to pack---	Percs slowly, floods.	Percs slowly, floods.	Percs slowly---	Percs slowly.
24----------------- Manzanola	Favorable------	Favorable------	Percs slowly---	Percs slowly---	Percs slowly---	Percs slowly.
25----------------- Midway	Depth to rock, slope.	Thin layer, hard to pack.	Percs slowly, depth to rock, slope.	Droughty, percs slowly, rooting depth.	Slope, depth to rock, erodes easily.	Slope, erodes easily, rooting depth.
26----------------- Norka	Seepage--------	Piping---------	Favorable------	Favorable------	Favorable------	Favorable.
27----------------- Olney	Seepage--------	Favorable------	Favorable------	Soil blowing---	Soil blowing---	Favorable.

See footnote at end of table.

TABLE 10.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
28 Otero	Seepage	Piping	Favorable	Droughty, soil blowing.	Soil blowing	Favorable.
29*. Playas						
30 Richfield	Seepage	Favorable	Not needed	Favorable	Erodes easily	Erodes easily.
31 Shingle	Slope, depth to rock.	Low strength, thin layer.	Depth to rock, slope.	Slope, rooting depth, droughty.	Depth to rock	Rooting depth, droughty.
32*: Singerton	Seepage	Piping	Favorable	Favorable	Favorable	Favorable.
Pultney	Slope, depth to rock.	Thin layer, excess salt.	Slope, depth to rock, excess salt.	Rooting depth, excess salt, droughty.	Depth to rock	Excess salt, rooting depth.
33 Stoneham	Seepage	Favorable	Favorable	Favorable	Favorable	Favorable.
34*: Stoneham	Seepage	Favorable	Favorable	Favorable	Favorable	Favorable.
Kim	Seepage	Favorable	Favorable	Favorable	Favorable	Favorable.
35 Sundance	Seepage	Favorable	Favorable	Soil blowing	Soil blowing	Favorable.
36*: Sundance	Seepage	Favorable	Favorable	Soil blowing	Soil blowing	Favorable.
Fort Collins	Seepage	Favorable	Percs slowly	Favorable	Favorable	Favorable.
37 Valent	Slope, seepage.	Piping	Slope	Slope, soil blowing, droughty.	Soil blowing	Droughty.
38*: Valent	Slope, seepage.	Piping	Slope	Slope, soil blowing, droughty.	Soil blowing	Droughty.
Blownout land.						
39 Vona	Seepage	Piping, seepage.	Favorable	Soil blowing	Soil blowing	Favorable.
40*: Vona	Slope, seepage.	Piping, seepage.	Slope	Slope, soil blowing.	Soil blowing	Favorable.
Stoneham	Seepage	Favorable	Favorable	Favorable	Favorable	Favorable.
41 Wiley	Seepage	Piping	Favorable	Erodes easily	Favorable	Erodes easily.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements				Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Openland wildlife	Rangeland wildlife
1: Absted	Poor	Poor	Fair	Fair	Poor	Fair.
2*:						
Arvada	Very poor	Very poor	Poor	Poor	Very poor	Poor.
Absted	Poor	Poor	Fair	Fair	Poor	Fair.
3: Baca	Poor	Fair	Fair	Fair	Fair	Fair.
4*:						
Baca	Poor	Good	Fair	Poor	Fair	Poor.
Wiley	Poor	Fair	Fair	Poor	Fair	Poor.
5*:						
Bankard	Poor	Fair	Fair	Fair	Fair	Fair.
Glenberg	Poor	Fair	Fair	Fair	Fair	Fair.
6: Bijou	Fair	Good	Fair	Fair	Fair	Fair.
7*:						
Bijou	Fair	Good	Fair	Fair	Fair	Fair.
Valent	Poor	Fair	Fair	Fair	Fair	Fair.
8: Cadoma	Poor	Poor	Fair	Fair	Poor	Fair.
9*:						
Canyon	Poor	Poor	Fair	Poor	Poor	Poor.
Rock outcrop.						
10, 11: Colby	Poor	Fair	Fair	Poor	Fair	Poor.
12*: Fluvaquents	Poor	Fair	Good	Fair	Fair	Fair.
13: Fort Collins	Fair	Fair	Fair	Fair	Fair	Fair.
14: Goshen	Good	Good	Fair	Fair	Good	Fair.
15, 16: Haverson	Fair	Fair	Fair	Fair	Fair	Fair.
17: Keyner	Poor	Poor	Fair	Fair	Poor	Fair.
18: Keyner Variant	Poor	Poor	Fair	Fair	Poor	Fair.
19*:						
Kim	Poor	Fair	Fair	Fair	Fair	Fair.
Canyon	Poor	Poor	Fair	Poor	Poor	Poor.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements				Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Openland wildlife	Rangeland wildlife
20*:						
Kim	Poor	Fair	Fair	Fair	Fair	Fair.
Harvey	Poor	Fair	Fair	Poor	Fair	Fair.
21*:						
Kim	Poor	Fair	Fair	Fair	Fair	Fair.
Harvey	Poor	Fair	Fair	Poor	Fair	Fair.
Stoneham	Poor	Fair	Fair	Fair	Fair	Fair.
22*:						
Kim	Poor	Fair	Fair	Fair	Fair	Fair.
Stoneham	Poor	Fair	Fair	Fair	Fair	Fair.
Larimer	Fair	Fair	Fair	Fair	Fair	Fair.
23 Limon	Poor	Poor	Fair	Fair	Poor	Fair.
24 Manzanola	Poor	Fair	Fair	Fair	Fair	Fair.
25 Midway	Very poor	Very poor	Fair	Fair	Poor	Fair.
26 Norka	Good	Good	Fair	Poor	Fair	Poor.
27 Olney	Poor	Fair	Fair	Fair	Fair	Fair.
28 Otero	Poor	Fair	Fair	Fair	Fair	Fair.
29* Playas	Very poor	Very poor	Poor	Poor	Very poor	Poor.
30 Richfield	Good	Good	Fair	Fair	Good	Fair.
31 Shingle	Poor	Poor	Fair	Fair	Poor	Fair.
32*:						
Singerton	Poor	Poor	Fair	Fair	Poor	Fair.
Pultney	Poor	Poor	Fair	Fair	Poor	Fair.
33 Stoneham	Poor	Fair	Fair	Fair	Fair	Fair.
34*:						
Stoneham	Poor	Fair	Fair	Fair	Fair	Fair.
Kim	Poor	Fair	Fair	Fair	Fair	Fair.
35 Sundance	Poor	Fair	Fair	Fair	Fair	Fair.
36*:						
Sundance	Poor	Fair	Fair	Fair	Fair	Fair.
Fort Collins	Fair	Fair	Fair	Fair	Fair	Fair.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements				Potential as habitat for--	
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Openland wildlife	Rangeland wildlife
37 Valent	Poor	Fair	Fair	Fair	Fair	Fair.
38*:						
Valent	Poor	Fair	Fair	Fair	Fair	Fair.
Blownout land.						
39 Vona	Poor	Fair	Fair	Fair	Fair	Fair.
40*:						
Vona	Poor	Poor	Fair	Fair	Fair	Fair.
Stoneham	Poor	Fair	Fair	Fair	Fair	Fair.
41 Wiley	Poor	Fair	Fair	Poor	Fair	Poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
1------------------ Absted	0-3	Clay------------	CH, CL	A-7	0	85-100	80-100	80-100	70-95	40-60	20-35
	3-60	Clay------------	CH, CL	A-7	0	85-100	80-100	80-100	70-95	40-60	20-35
2*:											
Arvada------------	0-2	Clay------------	CL	A-6, A-7	0	95-100	90-100	85-100	70-95	30-50	15-25
	2-60	Clay, clay loam, silty clay loam.	CH, CL	A-7, A-6	0	95-100	95-100	90-100	80-95	35-60	20-40
Absted------------	0-3	Clay------------	CH, CL	A-7	0	85-100	80-100	80-100	70-95	40-60	20-35
	3-60	Clay------------	CH, CL	A-7	0	85-100	80-100	80-100	70-95	40-60	20-35
3------------------ Baca	0-6	Loam------------	ML, CL-ML	A-4	0	100	100	85-100	65-90	20-30	NP-10**
	6-29	Clay, clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	75-100	35-50	15-30
	29-60	Silt loam, loam, silty clay loam	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-90	25-35	5-15
4*:											
Baca--------------	0-4	Clay loam-------	CL	A-6	0	100	100	85-95	70-90	25-35	10-15
	4-25	Silty clay loam, clay loam, clay.	CL	A-7, A-6	0	100	100	90-100	75-95	35-50	15-30
	25-60	Loam, silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	85-95	70-90	25-40	5-15
Wiley-------------	0-5	Silt loam-------	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	25-35	5-15
	5-16	Silty clay loam, silt loam, clay loam.	CL	A-6	0	100	100	90-100	70-95	25-35	10-20
	16-60	Silt loam, silty clay loam, loam.	CL-ML, CL	A-4, A-6	0	100	100	90-100	80-95	25-35	5-15
5*:											
Bankard-----------	0-4	Loamy fine sand	SP-SM, SM	A-2, A-3	0	95-100	80-100	50-75	5-25	---	NP
	4-60	Stratified loamy sand to sandy loam.	SP-SM, SM	A-2, A-3, A-1	0-5	80-100	75-95	40-70	5-25	---	NP
Glenberg----------	0-5	Fine sandy loam	SM	A-4, A-2	0	95-100	85-100	70-100	30-45	---	NP
	5-60	Stratified loamy sand to clay loam.	SM	A-2, A-4	0	90-100	75-100	50-100	25-40	---	NP
6------------------ Bijou	0-7	Loamy sand------	SM	A-2, A-1	0	90-100	90-100	40-85	15-30	---	NP
	7-24	Coarse sandy loam, sandy loam.	SC	A-2, A-6	0	90-100	90-100	35-80	25-40	20-40	10-20
	24-60	Loamy coarse sand, loamy sand, sand.	SM, SP-SM	A-1, A-2	0	90-100	90-100	30-70	5-30	---	NP
7*:											
Bijou-------------	0-7	Loamy sand------	SM	A-2, A-1	0	90-100	90-100	40-85	15-30	---	NP
	7-24	Coarse sandy loam, sandy loam.	SC	A-2, A-6	0	90-100	90-100	35-80	25-40	20-40	10-20
	24-60	Loamy coarse sand, loamy sand, sand.	SM, SP-SM	A-1, A-2	0	90-100	90-100	30-70	5-30	---	NP

See footnotes at end of table.

TABLE 12.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
7*:											
Valent	0-5	Loamy sand	SM, SP-SM	A-2	0	100	100	80-95	10-30	---	NP
	5-60	Fine sand, loamy fine sand, loamy sand.	SM	A-2	0	100	95-100	75-90	10-30	---	NP
8 Cadoma	0-4	Clay	CL, CH	A-7	0	95-100	95-100	80-90	75-85	40-55	25-35
	4-34	Clay, clay loam	CL, CH	A-7	0	100	100	80-90	75-85	40-55	25-35
	34	Weathered bedrock.	---	---	---	---	---	---	---	---	---
9*:											
Canyon	0-4	Gravelly loam	SM, GM	A-4	0-5	60-80	50-75	45-60	35-50	---	NP
	4-19	Very fine sandy loam, loam, clay loam.	ML, CL-ML	A-4	0-5	80-100	75-100	65-95	55-75	15-20	NP-10
	19	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Rock outcrop.											
10 Colby	0-4	Silt loam	CL-ML	A-4,	0	100	100	90-100	85-100	25-35	5-10
	4-60	Silt loam, loam, silty clay loam	CL-ML, CL	A-4, A-6	0	100	100	90-100	85-100	25-40	5-15
11 Colby	0-4	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	85-100	25-40	5-15
	4-60	Silt loam, loam, silty clay loam	CL-ML, CL	A-4, A-6	0	100	100	90-100	85-100	25-40	5-15
12*. Fluvaquents											
13 Fort Collins	0-6	Sandy loam	SM, ML	A-4, A-2	0	95-100	90-100	60-80	30-55	15-25	NP-5
	6-14	Loam, clay loam	CL	A-6	0	95-100	90-100	85-95	60-75	25-40	15-25
	14-60	Loam, clay loam	CL, CL-ML	A-4, A-6	0	95-100	90-100	80-95	50-75	25-35	5-15
14 Goshen	0-5	Silt loam	CL-ML	A-4,	0	100	90-100	90-100	70-95	20-35	5-10
	5-36	Silty clay loam, loam, silt loam.	CL, CL-ML	A-6, A-4	0	100	100	85-100	60-95	20-40	5-20
	36-60	Silt loam, loam,	CL, CL-ML	A-4, A-6	0	100	100	85-100	60-95	20-35	5-15
15, 16 Haverson	0-14	Clay loam	CL-ML, CL	A-4, A-6	0	95-100	80-100	75-95	60-80	20-40	5-15
	14-60	Stratified silty clay loam to sand.	ML	A-4	0	95-100	75-100	75-90	50-60	20-35	NP-10
17 Keyner	0-11	Loamy sand	SM	A-2	0	75-100	75-100	50-75	15-30	---	NP
	11-17	Sandy clay loam, sandy loam.	SC	A-6	0	75-100	75-100	60-90	35-50	30-40	15-20
	17-60	Fine sandy loam	SM	A-4	0	75-100	75-100	50-85	35-50	15-25	NP-5
18 Keyner Variant	0-10	Loamy sand	SM	A-2, A-1	0	95-100	90-100	45-75	15-30	---	NP
	10-24	Sandy clay loam, sandy loam, clay loam.	SC, CL	A-6	0	95-100	90-100	60-90	35-60	25-40	10-20
	24-60	Clay loam, clay	CL, CH	A-7	0	90-100	90-100	80-100	60-90	40-60	20-35
19*:											
Kim	0-4	Loam	ML	A-4	0-5	80-100	75-100	60-90	55-75	20-35	NP-5
	4-60	Loam, clay loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	80-100	75-100	70-95	40-85	25-40	5-15

See footnotes at end of table.

TABLE 12.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
19*:											
Canyon------------	0-4	Gravelly loam---	SM, GM	A-4	0-5	60-80	50-75	45-60	35-50	---	NP
	4-19	Very fine sandy loam, loam, gravelly loam.	ML, SM, GM	A-4	0-5	60-100	50-100	45-95	35-75	15-20	NP-10
	19	Weathered bedrock.	---	---	---	---	---	---	---	---	---
20*:											
Kim---------------	0-4	Loam------------	ML	A-4	0-5	80-100	75-100	60-90	55-75	20-35	NP-5
	4-60	Loam, clay loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	80-100	75-100	70-95	40-85	25-40	5-15
Harvey------------	0-5	Loam------------	CL-ML, ML	A-4	0	80-100	80-100	70-100	50-80	25-35	5-10
	5-50	Clay loam, sandy clay loam, loam.	CL-ML, CL, SC	A-4, A-6	0	80-100	80-100	70-100	35-80	25-40	5-15
	50-60	Gravelly sandy loam, gravelly sandy clay loam.	SM, SM-SC, SC, GM-GC	A-1, A-2	0-10	55-80	50-75	35-65	20-35	20-30	NP-10
21*:											
Kim---------------	0-4	Loam------------	ML	A-4	0-5	80-100	75-100	60-90	55-75	20-35	NP-5
	4-60	Loam, clay loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	80-100	75-100	70-95	40-85	25-40	5-15
Harvey------------	0-5	Loam------------	CL-ML, ML	A-4	0	80-100	80-100	70-100	50-80	25-35	5-10
	5-50	Clay loam, sandy clay loam, loam.	CL-ML, CL, SC	A-4, A-6	0	80-100	80-100	70-100	35-80	25-40	5-15
	50-60	Gravelly sandy loam, gravelly sandy clay loam.	SM, SM-SC, SC, GM-GC	A-1, A-2	0-10	55-80	50-75	35-65	20-35	20-30	NP-10
Stoneham----------	0-4	Loam------------	CL-ML	A-4	0	80-100	75-100	65-95	60-75	20-30	5-10
	4-13	Clay loam, sandy clay loam, loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	95-100	90-100	80-100	35-80	25-40	5-20
	13-60	Loam, clay loam	CL, SC, SM-SC, CL-ML	A-4, A-6	0	95-100	75-100	60-95	45-75	15-30	5-15
22*:											
Kim---------------	0-4	Loam------------	ML	A-4	0-5	80-100	75-100	60-90	55-75	20-35	NP-5
	4-60	Loam, clay loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	80-100	75-100	70-95	40-85	25-40	5-15
Stoneham----------	0-4	Loam------------	CL-ML	A-4	0	80-100	75-100	65-95	60-75	20-30	5-10
	4-13	Clay loam, sandy clay loam, loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	95-100	90-100	80-100	35-80	25-40	5-20
	13-60	Loam, clay loam	CL, SC, SM-SC, CL-ML	A-4, A-6	0	95-100	75-100	60-95	45-75	15-30	5-15

See footnotes at end of table.

TABLE 12.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
22*:											
Larimer	0-3	Loam	ML	A-4	0-5	85-100	75-100	70-95	50-75	20-25	NP-5
	3-11	Loam	CL	A-6	0-5	80-100	75-100	75-95	50-75	25-35	10-15
	11-28	Gravelly sandy clay loam, gravelly loam, sandy clay loam.	SM-SC, CL-ML	A-2, A-4	5-10	70-95	50-85	35-75	20-55	20-30	5-10
	28-60	Very gravelly sand, very cobbly sand, very gravelly loamy sand.	GP, GP-GM	A-1	25-50	25-40	20-30	5-15	0-10	---	NP
23 Limon	0-6	Clay	CL	A-6, A-7	0	100	95-100	95-100	70-90	30-50	15-30
	6-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	100	95-100	95-100	75-95	40-60	20-40
24 Manzanola	0-6	Clay loam	CL, CL-ML	A-4, A-6	0-5	95-100	80-95	70-95	50-75	25-40	5-20
	6-32	Clay loam, clay	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-85	35-50	20-30
	32-60	Clay loam, silty clay loam, clay	CL	A-6	0-5	95-100	90-100	85-95	60-80	30-40	10-20
25 Midway	0-5	Clay	CL	A-6, A-7	0	100	100	90-100	80-100	35-45	15-20
	5-10	Clay, silty clay loam, silty clay.	CL, CH	A-7	0	100	100	90-100	80-95	45-60	20-35
	10	Weathered bedrock.	---	---	---	---	---	---	---	---	---
26 Norka	0-7	Silt loam	ML, CL-ML	A-4	0	100	95-100	85-95	60-85	20-30	NP-10
	7-18	Silty clay loam, loam, clay loam.	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	85-95	20-35	5-15
	18-60	Loam, silt loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	95-100	90-95	85-95	15-25	NP-10
27 Olney	0-6	Loamy sand	SM	A-2	0	95-100	90-100	60-90	15-25	---	NP
	6-27	Sandy clay loam, sandy loam.	SC, CL	A-6	0	95-100	90-100	80-100	40-55	20-40	10-20
	27-60	Sandy loam, sandy clay loam, fine sandy loam.	SC, SM-SC, CL, CL-ML	A-4, A-6	0	95-100	95-100	75-95	35-55	20-35	5-15
28 Otero	0-2	Sandy loam	SM	A-2	0-1	95-100	75-100	50-80	10-35	---	NP
	2-60	Sandy loam, fine sandy loam.	SM	A-2, A-1	0-1	90-100	75-100	60-80	20-35	15-25	NP-5
29*. Playas											
30 Richfield	0-7	Silt loam	CL-ML,	A-4,	0	100	100	90-100	70-100	20-35	5-10
	7-22	Silty clay loam, silty clay.	CL, CH	A-7-6	0	100	100	95-100	90-100	40-60	20-35
	22-60	Silty clay loam, silt loam.	CL-ML, CL	A-4, A-6, A-7	0	100	100	95-100	85-100	25-45	5-20
31 Shingle	0-16	Clay loam	CL	A-6	0-5	75-100	75-100	70-100	55-80	35-40	15-20
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnotes at end of table.

TABLE 12.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
32*:											
Singerton---------	0-6	Loam------------	ML, CL	A-4, A-6	0	90-100	90-100	55-90	50-80	30-40	5-15
	6-60	Clay loam, loam	ML, MH, SM	A-4, A-6, A-7	0	80-100	75-100	50-85	45-80	25-55	5-20
Pultney----------	0-6	Clay loam-------	CL	A-6	0	95-100	95-100	80-95	60-75	30-40	10-15
	6-25	Clay loam, silty clay loam.	CL	A-6	0	95-100	90-100	85-100	65-85	30-40	10-15
	25	Weathered bedrock.	---	---	---	---	---	---	---	---	---
33---------------- Stoneham	0-4	Loam------------	CL-ML	A-4	0	80-100	75-100	65-95	60-75	20-30	5-10
	4-13	Clay loam, sandy clay loam, loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	95-100	90-100	80-100	35-80	25-40	5-20
	13-60	Loam, clay loam.	CL, SC, SM-SC, CL-ML	A-4, A-6	0	95-100	75-100	60-95	45-75	15-30	5-15
34*:											
Stoneham---------	0-4	Loam------------	CL-ML	A-4	0	80-100	75-100	65-95	60-75	20-30	5-10
	4-8	Clay loam, sandy clay loam, loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	95-100	90-100	80-100	35-80	25-40	5-20
	8-60	Loam, clay loam.	CL, SC, SM-SC, CL-ML	A-4, A-6	0	95-100	75-100	60-95	45-75	15-30	5-15
Kim--------------	0-4	Loam------------	ML	A-4	0-5	80-100	75-100	60-90	55-75	20-35	NP-5
	4-60	Loam, clay loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	80-100	75-100	70-95	40-85	25-40	5-15
35---------------- Sundance	0-8	Loamy sand------	SM	A-2	0	95-100	90-100	55-80	15-30	---	NP
	8-17	Sandy loam, sandy clay loam.	SM-SC, CL-ML	A-4	0	95-100	90-100	60-80	35-55	20-30	5-10
	17-28	Clay loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-85	25-40	10-20
	28-60	Silt loam-------	CL-ML, CL	A-4, A-6	0	100	100	90-100	85-100	25-40	5-15
36*:											
Sundance---------	0-7	Loamy sand------	SM	A-2	0	95-100	90-100	55-80	15-30	---	NP
	7-14	Sandy loam, sandy clay loam.	SM-SC, CL-ML	A-4	0	95-100	90-100	60-80	35-55	20-30	5-10
	14-24	Clay loam, silty clay loam.	CL	A-6	0	100	100	90-100	70-85	25-40	10-20
	24-60	Silt loam-------	CL-ML, CL	A-4, A-6	0	100	100	90-100	85-100	25-40	5-15
Fort Collins------	0-6	Sandy loam------	SM, ML	A-4, A-2	0	95-100	90-100	60-80	30-55	15-25	NP-5
	6-14	Loam, clay loam.	CL	A-6	0	95-100	90-100	85-95	60-75	25-40	15-25
	14-60	Loam------------	CL, CL-ML	A-4, A-6	0	95-100	90-100	80-95	50-75	25-35	5-15
37---------------- Valent	0-5	Loamy sand------	SM	A-2	0	100	100	80-95	10-30	---	NP
	5-60	Fine sand, loamy fine sand, loamy sand.	SM	A-2	0	100	95-100	75-90	10-30	---	NP

See footnotes at end of table.

TABLE 12.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
38*:											
Valent	0-5	Sand	SP-SM, SM	A-2, A-3	0	100	100	70-90	5-15	---	NP
	5-60	Fine sand, loamy fine sand, loamy sand.	SM	A-2	0	100	95-100	75-90	10-30	---	NP
Blownout land.											
39 Vona	0-4	Sandy loam	SM	A-2, A-4	0	100	90-100	60-90	30-45	---	NP
	4-16	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	90-100	60-90	30-45	---	NP
	16-60	Sandy loam, loamy sand.	SM	A-2	0	100	90-100	50-85	15-30	---	NP
40*:											
Vona	0-4	Sandy loam	SM	A-2, A-4	0	100	90-100	60-90	30-45	---	NP
	4-16	Fine sandy loam, sandy loam.	SM	A-2, A-4	0	100	90-100	60-90	30-45	---	NP
	16-60	Sandy loam, loamy sand.	SM	A-2	0	100	90-100	50-85	15-30	---	NP
Stoneham	0-4	Sandy loam	SM, ML	A-4, A-2	0	80-100	75-100	60-85	30-55	10-20	NP-5
	4-13	Clay loam, sandy clay loam, loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	95-100	90-100	80-100	35-80	25-40	5-20
	13-60	Loam, clay loam.	CL, SC, SM-SC, CL-ML	A-4, A-6	0	95-100	75-100	60-95	45-75	15-30	5-15
41 Wiley	0-5	Loam	CL-ML, CL	A-4, A-6	0	100	100	90-100	70-90	25-35	5-15
	5-16	Silty clay loam, silt loam, clay loam.	CL	A-6	0	100	100	90-100	70-95	25-35	10-20
	16-60	Silt loam, silty clay loam, loam.	CL-ML, CL	A-4, A-6	0	100	100	90-100	80-95	25-35	5-15

* See description of the map unit for composition and behavior characteristics of the map unit.
** NP means nonplastic.

TABLE 13.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	In/hr	In/in	pH	Mmhos/cm					Pct
1----------------- Absted	0-3	40-55	0.06-0.2	0.11-0.13	7.9-8.4	2-8	High-------	0.32	5	4L	0.5-1
	3-60	40-55	0.06-0.2	0.07-0.09	7.9-9.0	>16	High-------	0.37			
2*:											
Arvada-----------	0-2	40-50	0.06-0.2	0.07-0.12	>7.8	>4	High-------	0.32	5	4L	.5-1
	2-60	35-60	0.06-0.2	0.07-0.12	>8.4	>4	High-------	0.37			
Absted-----------	0-3	40-55	0.06-0.2	0.11-0.13	7.9-8.4	2-8	High-------	0.32	5	4L	.5-1
	3-60	40-55	0.06-0.2	0.07-0.09	7.9-9.0	>16	High-------	0.37			
3----------------- Baca	0-6	20-25	0.6-2.0	0.18-0.20	7.4-8.4	<2	Low--------	0.32	5	6	1-3
	6-29	35-45	0.2-0.6	0.16-0.18	7.4-8.4	<2	Moderate	0.32			
	29-60	15-35	0.6-2.0	0.16-0.18	7.4-8.4	<2	Moderate	0.43			
4*:											
Baca-------------	0-4	28-35	0.6-2.0	0.18-0.20	6.6-8.4	<2	Moderate	0.28	5	4	1-2
	4-25	35-45	0.2-0.6	0.16-0.18	7.4-8.4	<2	Moderate	0.24			
	25-60	15-30	0.6-2.0	0.16-0.18	7.9-8.4	<2	Moderate	0.43			
Wiley------------	0-5	15-27	0.6-2.0	0.19-0.21	7.9-8.4	<2	Low--------	0.37	5	4L	.5-1
	5-16	18-35	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate	0.37			
	16-60	18-35	0.6-2.0	0.16-0.21	7.9-9.0	<2	Moderate	0.43			
5*:											
Bankard----------	0-4	2-10	6.0-20	0.05-0.08	7.4-8.4	<2	Low--------	0.10	5	2	.5-1
	4-60	2-10	6.0-20	0.05-0.08	7.4-8.4	<2	Low--------	0.10			
Glenberg---------	0-5	10-20	2.0-6.0	0.09-0.13	7.4-8.4	<2	Low--------	0.17	5	3	.5-1
	5-60	8-18	2.0-6.0	0.07-0.12	7.4-9.0	<2	Low--------	0.10			
6----------------- Bijou	0-7	4-10	6.0-20	0.06-0.08	6.6-7.8	<2	Low--------	0.10	5	2	.5-2
	7-24	12-18	6.0-20	0.10-0.12	6.6-7.8	<2	Low--------	0.20			
	24-60	2-10	6.0-20	0.05-0.07	6.6-7.8	<2	Low--------	0.15			
7*:											
Bijou------------	0-7	4-10	6.0-20	0.06-0.08	6.6-7.8	<2	Low--------	0.10	5	2	.5-2
	7-24	12-18	6.0-20	0.10-0.12	6.6-7.8	<2	Low--------	0.20			
	24-60	2-10	6.0-20	0.05-0.07	6.6-7.8	<2	Low--------	0.15			
Valent-----------	0-5	3-10	6.0-20	0.07-0.12	6.6-7.8	<2	Low--------	0.10	5	1	.5-1
	5-60	2-8	6.0-20	0.05-0.10	6.6-7.8	<2	Low--------	0.10			
8----------------- Cadoma	0-4	40-50	0.06-0.2	0.14-0.16	>7.8	>4	High-------	0.32	3	4L	.5-1
	4-34	35-60	0.06-0.2	0.08-0.12	>7.8	>6	High-------	0.37			
	34	---	---	---	---	---	-----------	----			
9*:											
Canyon-----------	0-4	5-15	0.6-2.0	0.15-0.18	7.4-8.4	<2	Low--------	0.24	2	4L	.5-1
	4-19	5-35	0.6-2.0	0.13-0.18	7.4-8.4	<2	Low--------	0.32			
	19	---	---	---	---	---	-----------	----			
Rock outcrop.											
10---------------- Colby	0-4	15-30	0.6-2.0	0.18-0.20	7.4-8.4	<2	Low--------	0.37	5	4L	.5-2
	4-60	18-30	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low--------	0.43			
11---------------- Colby	0-4	15-30	0.6-2.0	0.18-0.20	7.4-8.4	<2	Low--------	0.37	5	4L	.5-2
	4-60	18-30	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low--------	0.43			
12*. Fluvaquents											

See footnote at end of table.

TABLE 13.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	In/hr	In/in	pH	Mmhos/cm					Pct
13------------- Fort Collins	0-6	12-20	0.6-6.0	0.14-0.17	7.4-7.8	<2	Low-------	0.17	5	3	1-2
	6-14	18-35	0.6-2.0	0.16-0.18	6.6-8.4	<2	Moderate	0.24			
	14-60	15-30	0.6-2.0	0.16-0.18	7.4-9.0	<2	Moderate	0.24			
14------------- Goshen	0-5	18-35	0.6-2.0	0.20-0.22	6.6-7.8	<2	Low-------	0.32	5	5	1-3
	5-36	18-35	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.43			
	36-60	15-30	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low-------	0.43			
15, 16---------- Haverson	0-14	27-35	0.2-0.6	0.16-0.19	7.4-8.4	<8	Moderate	0.28	5	4L	.5-2
	14-60	18-35	0.6-2.0	0.14-0.18	7.4-9.0	<8	Low-------	0.28			
17------------- Keyner	0-11	3-8	2.0-6.0	0.06-0.08	7.4-8.4	<8	Low-------	0.10	5	2	---
	11-17	25-35	0.06-0.2	0.10-0.12	>7.8	>8	Moderate	0.24			
	17-60	5-12	2.0-6.0	0.06-0.08	>7.8	>8	Low-------	0.20			
18------------- Keyner Variant	0-10	3-7	2.0-6.0	0.06-0.08	7.4-8.4	<2	Low-------	0.10	3	2	.5-1
	10-24	16-30	0.2-0.6	0.05-0.07	7.9-9.0	4-16	Moderate	0.24			
	24-60	37-60	<0.06	0.03-0.05	>8.4	>16	High------	0.37			
19*:											
Kim------------	0-4	15-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low-------	0.32	5	4L	.5-1
	4-60	20-35	0.6-2.0	0.15-0.17	7.9-8.4	<8	Moderate	0.32			
Canyon----------	0-4	5-15	0.6-2.0	0.15-0.18	7.4-8.4	<2	Low-------	0.24	2	4L	.5-1
	4-19	5-20	0.6-2.0	0.13-0.18	7.4-8.4	<2	Low-------	0.32			
	19	---	---	---	---	---	----------	----			
20*:											
Kim------------	0-4	15-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low-------	0.32	5	4L	.5-1
	4-60	20-35	0.6-2.0	0.15-0.17	7.9-8.4	<8	Moderate	0.32			
Harvey----------	0-5	15-25	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low-------	0.37	5	4L	.5-1
	5-50	15-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Moderate	0.37			
	50-60	10-25	0.6-2.0	0.09-0.12	7.4-8.4	<2	Low-------	0.32			
21*:											
Kim------------	0-4	15-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low-------	0.32	5	4L	.5-1
	4-60	20-35	0.6-2.0	0.15-0.17	7.9-8.4	<8	Moderate	0.32			
Harvey----------	0-5	15-25	0.6-2.0	0.16-0.18	7.4-8.4	<2	Low-------	0.37	5	4L	.5-1
	5-50	15-35	0.6-2.0	0.14-0.18	7.9-8.4	<2	Moderate	0.37			
	50-60	10-25	0.6-2.0	0.09-0.12	7.9-8.4	<2	Low-------	0.32			
Stoneham--------	0-4	15-27	0.6-2.0	0.16-0.18	6.6-8.4	<2	Low-------	0.24	5	4L	.5-2
	4-13	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Moderate	0.32			
	13-60	10-30	0.6-2.0	0.14-0.18	7.9-8.4	<2	Moderate	0.32			
22*:											
Kim------------	0-4	15-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low-------	0.32	5	4L	.5-1
	4-60	20-35	0.6-2.0	0.15-0.17	7.9-8.4	<8	Moderate	0.32			
Stoneham--------	0-4	15-27	0.6-2.0	0.16-0.18	6.6-8.4	<2	Low-------	0.24	5	4L	.5-2
	4-13	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Moderate	0.32			
	13-60	10-30	0.6-2.0	0.14-0.18	7.9-8.4	<2	Moderate	0.32			
Larimer---------	0-3	15-27	0.6-2.0	0.14-0.17	6.6-8.4	<2	Low-------	0.24	3	4	2-3
	3-11	15-27	0.6-2.0	0.16-0.18	7.4-8.4	<2	Moderate	0.32			
	11-28	15-35	2.0-6.0	0.11-0.13	7.9-9.0	<2	Low-------	0.20			
	28-60	0-5	>20	0.03-0.05	7.9-8.4	<2	Low-------	0.10			
23------------- Limon	0-6	40-60	0.2-0.6	0.14-0.17	7.4-8.4	2-8	High------	0.24	5	4L	.5-1
	6-60	35-60	0.06-0.2	0.12-0.16	7.9-9.0	2-8	High------	0.32			
24------------- Manzanola	0-6	30-35	0.2-2.0	0.19-0.20	7.4-8.4	<4	Moderate	0.24	5	4L	1-2
	6-32	35-45	0.06-0.2	0.15-0.18	7.4-9.0	<2	High------	0.28			
	32-60	30-50	0.2-0.6	0.16-0.18	7.4-9.0	<8	Moderate	0.24			

See footnote at end of table.

TABLE 13.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	In/hr	In/in	pH	Mmhos/cm					Pct
25	0-5	40-45	0.2-0.6	0.12-0.18	7.4-8.4	2-4	High	0.43	1	4L	0.5-2
Midway	5-10	35-45	0.06-0.2	0.12-0.17	7.9-9.0	2-8	High	0.43			
	10	---	---	---	---	---	---	---			
26	0-7	5-15	0.6-2.0	0.16-0.21	6.6-7.8	<2	Low	0.32	5	5	1-2
Norka	7-18	20-35	0.2-0.6	0.16-0.21	7.4-7.8	<2	Moderate	0.32			
	18-60	5-15	0.6-2.0	0.16-0.21	7.9-8.4	<2	Low	0.43			
27	0-6	5-10	6.0-20	0.06-0.10	6.6-7.8	<2	Low	0.15	5	2	.5-2
Olney	6-27	18-30	0.6-2.0	0.13-0.15	6.6-7.8	<2	Moderate	0.24			
	27-60	15-30	0.6-6.0	0.11-0.15	7.9-8.4	<2	Low	0.24			
28	0-2	10-20	6.0-20	0.11-0.13	7.4-8.4	<2	Low	0.15	5	3	.5-2
Otero	2-60	10-20	6.0-20	0.08-0.12	7.4-8.4	<4	Low	0.15			
29*. Playas											
30	0-7	10-24	0.6-2.0	0.20-0.24	6.6-7.8	<2	Low	0.32	5	6	1-3
Richfield	7-22	35-42	0.2-6.0	0.14-0.19	6.6-8.4	<2	High	0.43			
	22-60	18-35	0.6-2.0	0.18-0.22	7.9-9.0	<2	Moderate	0.43			
31	0-16	28-40	0.6-2.0	0.19-0.21	7.4-9.0	<2	Moderate	0.32	2	4L	.5-1
Shingle	16	---	---	---	---	---	---	---			
32*:											
Singerton	0-6	15-27	0.6-2.0	0.15-0.17	7.4-8.4	<4	Low	0.24	5	4L	.5-1
	6-60	18-35	0.6-2.0	0.10-0.12	7.9-9.0	<8	Moderate	0.28			
Pultney	0-6	20-35	0.6-2.0	0.15-0.17	7.9-8.4	2-8	Moderate	0.32	2	4L	.5-2
	6-25	20-35	0.2-0.6	0.12-0.15	7.9-8.4	4-16	Moderate	0.37			
	25	---	---	---	---	---	---	---			
33	0-4	15-27	0.6-2.0	0.16-0.18	6.6-8.4	<2	Low	0.24	5	4L	.5-2
Stoneham	4-13	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Moderate	0.32			
	13-60	10-20	0.6-2.0	0.14-0.18	7.9-8.4	<2	Moderate	0.32			
34*:											
Stoneham	0-4	15-27	0.6-2.0	0.16-0.18	6.6-8.4	<2	Low	0.24	5	4L	.5-2
	4-8	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Moderate	0.32			
	8-60	10-30	0.6-2.0	0.14-0.18	7.9-8.4	<2	Moderate	0.32			
Kim	0-4	15-27	0.6-2.0	0.16-0.18	7.9-8.4	<2	Low	0.32	5	4L	.5-1
	4-60	20-35	0.6-2.0	0.15-0.17	7.9-8.4	<8	Moderate	0.32			
35	0-8	5-10	>6.0	0.06-0.08	6.6-7.3	<2	Low	0.15	5	2	.5-1
Sundance	8-17	15-25	0.6-2.0	0.10-0.13	6.6-7.3	<2	Low	0.20			
	17-28	27-35	0.2-0.6	0.16-0.18	7.4-8.4	<2	Moderate	0.32			
	28-60	10-25	0.6-2.0	0.16-0.18	7.9-8.4	<2	Moderate	0.43			
36*:											
Sundance	0-7	5-10	>6.0	0.06-0.08	6.6-7.3	<2	Low	0.15	5	2	.5-1
	7-14	15-25	0.6-2.0	0.10-0.13	6.6-7.3	<2	Low	0.20			
	14-24	27-35	0.2-0.6	0.16-0.18	7.4-8.4	<2	Moderate	0.32			
	24-60	10-25	0.6-2.0	0.16-0.18	7.9-8.4	<2	Moderate	0.43			
Fort Collins	0-6	12-20	0.6-6.0	0.14-0.17	7.4-7.8	<2	Low	0.17	5	3	1-2
	6-14	18-35	0.6-2.0	0.16-0.18	7.4-8.4	<2	Moderate	0.24			
	14-60	12-27	0.6-2.0	0.16-0.18	7.4-9.0	<2	Moderate	0.24			
37	0-5	3-10	6.0-20	0.07-0.12	6.6-7.8	<2	Low	0.10	5	1	.5-1
Valent	5-60	2-8	6.0-20	0.05-0.10	6.6-7.8	<2	Low	0.10			
38*:											
Valent	0-5	2-6	6.0-20	0.05-0.10	6.6-7.8	<2	Low	0.10	5	1	.5-1
	5-60	2-8	6.0-20	0.05-0.10	6.6-7.8	<2	Low	0.10			
Blownout land.											

See footnote at end of table.

TABLE 13.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Clay <2mm	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	In/hr	In/in	pH	Mmhos/cm					Pct
39---------------- Vona	0-4	5-10	2.0-6.0	0.11-0.13	6.6-7.8	<2	Low--------	0.15	5	3	0.5-1
	4-16	12-18	2.0-6.0	0.12-0.14	6.6-8.4	<4	Low--------	0.20			
	16-60	3-10	6.0-20	0.08-0.11	7.9-9.0	<4	Low--------	0.15			
40*:											
Vona-------------	0-4	5-10	2.0-6.0	0.11-0.13	6.6-7.8	<2	Low--------	0.15	5	3	.5-1
	4-16	12-18	2.0-6.0	0.12-0.14	6.6-8.4	<4	Low--------	0.20			
	16-60	3-10	6.0-20	0.08-0.11	7.9-9.0	<4	Low--------	0.15			
Stoneham---------	0-4	10-20	2.0-6.0	0.11-0.15	6.6-8.4	<2	Low--------	0.17	5	3	.5-1
	4-13	20-35	0.6-2.0	0.14-0.18	7.4-8.4	<2	Moderate	0.32			
	13-60	10-30	0.6-2.0	0.14-0.18	7.9-8.4	<2	Moderate	0.32			
41---------------- Wiley	0-5	15-27	0.6-2.0	0.19-0.21	7.4-8.4	<2	Low--------	0.37	5	4L	.5-1
	5-16	18-35	0.6-2.0	0.19-0.21	7.9-8.4	<2	Moderate	0.37			
	16-60	18-35	0.6-2.0	0.16-0.21	7.9-9.0	<2	Moderate	0.43			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--SOIL AND WATER FEATURES

[The definition of "flooding" in the Glossary explain terms such as "rare," and "brief." The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness		Uncoated steel	Concrete
					In				
1 Absted	C	Rare	---	---	>60	---	Low	High	High.
2*:									
Arvada	D	Rare	---	---	>60	---	Low	High	High.
Absted	C	Rare	---	---	>60	---	Low	High	High.
3 Baca	C	Rare	---	---	>60	---	Low	High	Low.
4*:									
Baca	C	None	---	---	>60	---	Low	High	Low.
Wiley	B	None	---	---	>60	---	Low	High	Low.
5*:									
Bankard	A	Common	Brief	Mar-Jun	>60	---	Low	Moderate	Low.
Glenberg	B	Common	Very brief	Apr-Aug	>60	---	Low	High	Low.
6 Bijou	B	None	---	---	>60	---	Low	Moderate	Low.
7*:									
Bijou	B	None	---	---	>60	---	Low	Moderate	Low.
Valent	A	None	---	---	>60	---	Low	Low	Low.
8 Cadoma	C	None	---	---	20-40	Rippable	Low	High	High.
9*:									
Canyon	D	None	---	---	7-20	Rippable	Low	Low	Low.
Rock outcrop.									
10, 11 Colby	B	None	---	---	>60	---	Low	Low	Low.
12*. Fluvaquents									
13 Fort Collins	B	None	---	---	>60	---	Low	High	Low.
14 Goshen	B	Common	Very brief	Mar-Sep	>60	---	Moderate	High	Low.
15 Haverson	B	Rare	Brief	May-Sep	>60	---	Low	High	Low.
16 Haverson	B	Common	Brief	May-Sep	>60	---	Low	High	Low.
17 Keyner	D	None	---	---	>60	---	Low	High	Low.
18 Keyner Variant	C	Rare	---	---	>60	---	Low	High	Moderate.

See footnote at end of table.

TABLE 14.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness		Uncoated steel	Concrete
					In				
19*:									
Kim	B	None	---	---	>60	---	Low	High	Low.
Canyon	D	None	---	---	7-20	Rippable	Low	Low	Low.
20*:									
Kim	B	None	---	---	>60	---	Low	High	Low.
Harvey	B	None	---	---	>60	---	Low	High	Low.
21*:									
Kim	B	None	---	---	>60	---	Low	High	Low.
Harvey	B	None	---	---	>60	---	Low	High	Low.
Stoneham	B	None	---	---	>60	---	Low	High	Low.
22*:									
Kim	B	None	---	---	>60	---	Low	High	Low.
Stoneham	B	None	---	---	>60	---	Low	High	Low.
Larimer	B	None	---	---	>60	---	Low	High	Low.
23 Limon	C	Occasional	Brief	May-Sep	>60	---	Low	High	Moderate.
24 Manzanola	C	None	---	---	>60	---	Low	High	Moderate.
25 Midway	D	None	---	---	10-20	Rippable	Low	High	Low.
26 Norka	B	None	---	---	>60	---	Moderate	High	Low.
27 Olney	B	None	---	---	>60	---	Low	High	Low.
28 Otero	B	None	---	---	>60	---	Low	High	Low.
29*. Playas									
30 Richfield	C	None	---	---	>60	---	Low	High	Low.
31 Shingle	D	None	---	---	10-20	Rippable	Low	High	Low.
32*:									
Singerton	B	None	---	---	>60	---	Low	High	Moderate.
Pultney	C	None	---	---	20-40	Rippable	Low	High	High.
33 Stoneham	B	None	---	---	>60	---	Low	High	Low.
34*:									
Stoneham	B	None	---	---	>60	---	Low	High	Low.
Kim	B	None	---	---	>60	---	Low	High	Low.
35 Sundance	B	None	---	---	>60	---	Low	High	Low.

See footnote at end of table.

TABLE 14.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness		Uncoated steel	Concrete
					In				
36*:									
Sundance	B	None	---	---	>60	---	Low	High	Low.
Fort Collins	B	None	---	---	>60	---	Low	High	Low.
37 Valent	A	None	---	---	>60	---	Low	Low	Low.
38*:									
Valent	A	None	---	---	>60	---	Low	Low	Low.
Blownout land.									
39 Vona	B	None	---	---	>60	---	Low	High	Low.
40*:									
Vona	B	None	---	---	>60	---	Low	High	Low.
Stoneham	B	None	---	---	>60	---	Low	High	Low.
41 Wiley	B	None	---	---	>60	---	Low	High	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Absted	Fine, montmorillonitic, mesic Haplustollic Natrargids
Arvada	Fine, montmorillonitic, mesic Ustollic Natrargids
Baca	Fine, montmorillonitic, mesic Ustollic Haplargids
Bankard	Sandy, mixed, mesic Ustic Torrifluvents
Bijou	Coarse-loamy, mixed, mesic Ustollic Haplargids
Cadoma	Fine, montmorillonitic, mesic Ustollic Camborthids
Canyon	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents
Colby	Fine-silty, mixed (calcareous), mesic Ustic Torriorthents
Fort Collins	Fine-loamy, mixed, mesic Ustollic Haplargids
Glenberg	Coarse-loamy, mixed (calcareous), mesic Ustic Torrifluvents
Goshen	Fine-silty, mixed, mesic Pachic Argiustolls
Harvey	Fine-loamy, mixed, mesic Ustollic Calciorthids
Haverson	Fine-loamy, mixed (calcareous), mesic Ustic Torrifluvents
Keyner	Fine-loamy, mixed, mesic Haplustollic Natrargids
Keyner Variant	Fine-loamy, mixed, mesic Haplustollic Natrargids
Kim	Fine-loamy, mixed (calcareous), mesic Ustic Torriorthents
Larimer	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Ustollic Haplargids
Limon	Fine, montmorillonitic (calcareous), mesic Ustertic Torriorthents
Manzanola	Fine, montmorillonitic, mesic Ustollic Haplargids
Midway	Clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthents
Norka	Fine-silty, mixed, mesic Aridic Argiustolls
Olney	Fine-loamy, mixed, mesic Ustollic Haplargids
Otero	Coarse-loamy, mixed (calcareous), mesic Ustic Torriorthents
Pultney	Fine-loamy, mixed, mesic Ustollic Calciorthids
Richfield	Fine, montmorillonitic, mesic Aridic Argiustolls
Shingle	Loamy, mixed (calcareous), mesic, shallow Ustic Torriorthents
Singerton	Fine-loamy, carbonatic, mesic Ustollic Calciorthids
Stoneham	Fine-loamy, mixed, mesic Ustollic Haplargids
Sundance	Fine-loamy, mixed, mesic Ustollic Haplargids
Valent	Mixed, mesic Ustic Torripsamments
Vona	Coarse-loamy, mixed, mesic Ustollic Haplargids
Wiley	Fine-silty, mixed, mesic Ustollic Haplargids

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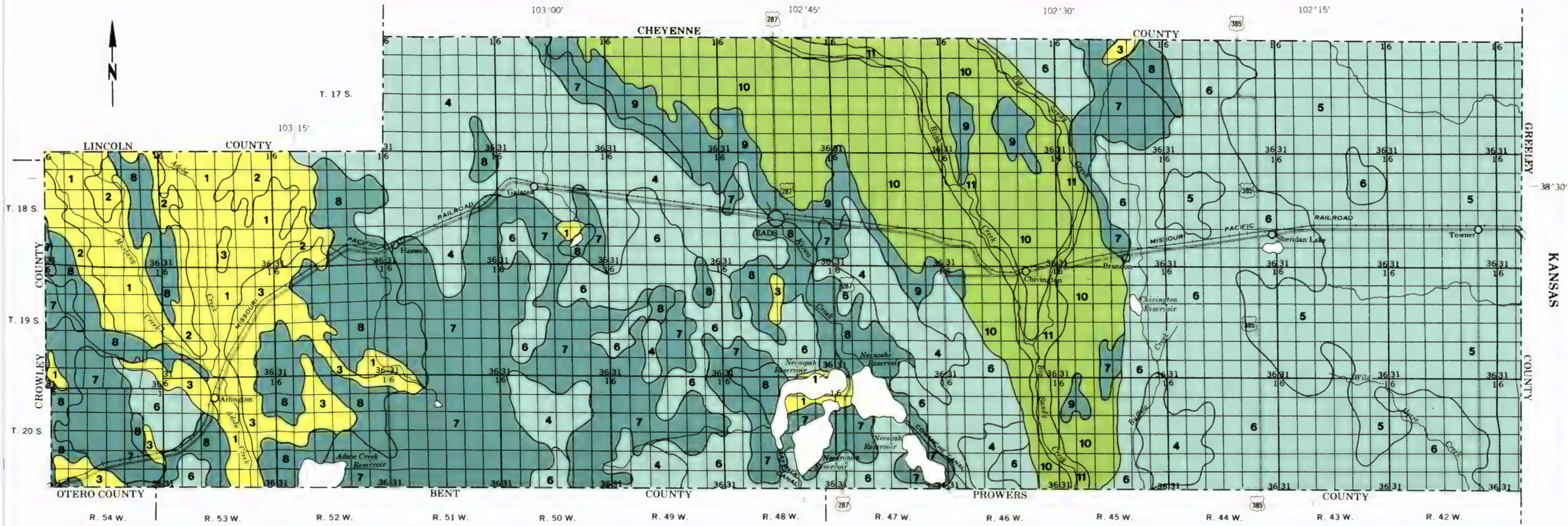


MAP UNITS

DOMINANTLY NEARLY LEVEL TO STRONGLY SLOPING SOILS FORMED IN MATERIAL DERIVED FROM SHALE

1	Absted-Limon: Nearly level, well drained, deep soils; on terraces and flood plains
2	Cadoma-Midway: Nearly level to strongly sloping, well drained, moderately deep and shallow soils; on upland plains
3	Singerton-Pultney: Nearly level to moderately sloping, well drained, deep and moderately deep soils; on plains and side slopes of uplands

DOMINANTLY NEARLY LEVEL TO GENTLY SLOPING SOILS THAT FORMED IN LOESS

4	Baca-Wiley: Nearly level, well drained deep soils; on flats and plains of uplands
5	Norka-Richfield: Nearly level, well drained, deep soils; on flats and smooth hillsides of uplands
6	Wiley-Colby: Nearly level to gently sloping, well drained, deep soils; on upland plains

DOMINANTLY NEARLY LEVEL TO STRONGLY SLOPING SOILS THAT FORMED IN LOAMY MATERIAL

7	Fort Collins-Stoneham-Vona: Nearly level to strongly sloping, well drained, deep soils; on plains and side slopes of uplands
8	Stoneham-Kim: Nearly level to strongly sloping, well drained, deep soils; on upland plains
9	Sundance-Olney: Nearly level, well drained, deep soils; on upland plains

DOMINANTLY NEARLY LEVEL TO MODERATELY SLOPING SOILS THAT FORMED IN SANDY MATERIAL

10	Valent-Bijou: Nearly level to moderately sloping, somewhat excessively drained, deep soils; on sand hills
11	Bankard-Fluvaquents: Nearly level, somewhat excessively drained to poorly drained, deep soils; on terraces and flood plains

Compiled 1979

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
COLORADO AGRICULTURAL EXPERIMENT STATION

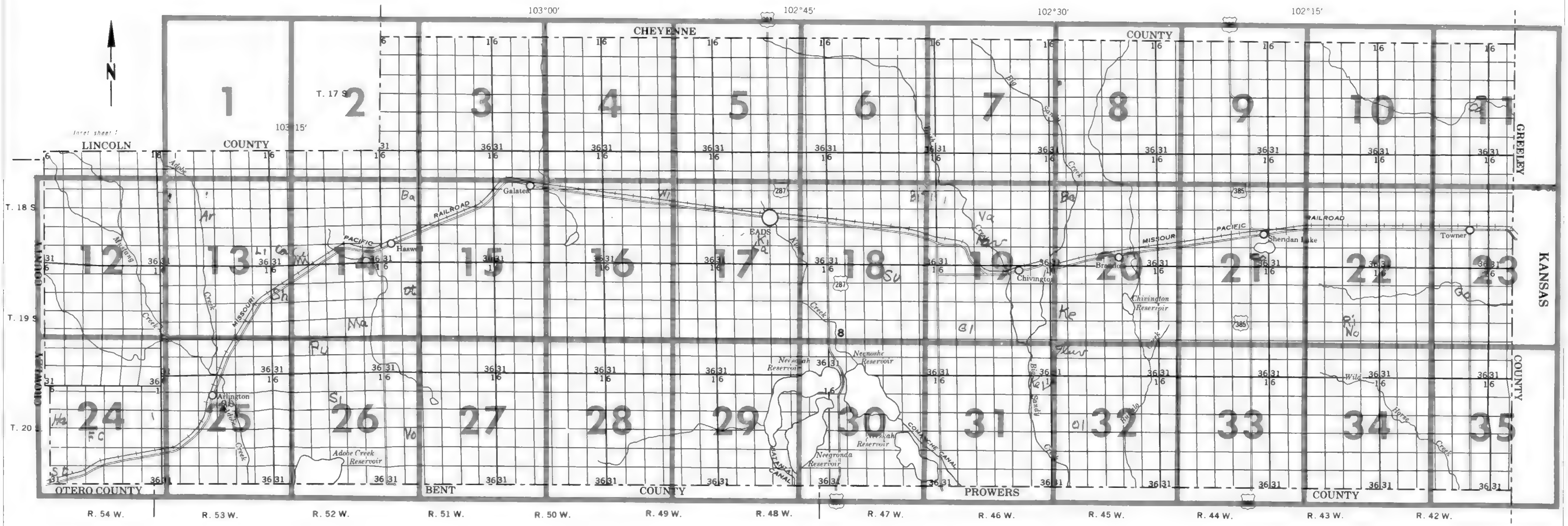
GENERAL SOIL MAP

KIOWA COUNTY, COLORADO

Scale 1:316,800

1 0 1 2 3 4 5 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



INDEX TO MAP SHEETS

KIOWA COUNTY, COLORADO

Scale 1:316,800

1 0 1 2 3 4 5 Miles

SOIL LEGEND

SYMBOL	NAME
1	Absted clay, 0 to 1 percent slopes
2	Arvada-Absted clays, 0 to 2 percent slopes
3	Baca loam, 0 to 1 percent slopes
4	Baca Wiley complex, 0 to 2 percent slopes
5	Bankard-Glenberg complex
6	Bijou loamy sand, 0 to 2 percent slopes
7	Bijou-Valent loamy sands, 1 to 8 percent slopes
8	Cadoma clay, 1 to 8 percent slopes
9	Canyon-Rock outcrop complex, 1 to 20 percent slopes
10	Colby silt loam, 1 to 3 percent slopes
11	Colby silt loam, 3 to 9 percent slopes
12	Fluvaquents, nearly level*
13	Fort Collins sandy loam, 0 to 3 percent slopes
14	Goshen silt loam
15	Haverson clay loam
16	Haverson clay loam, saline
17	Keyner loamy sand, 0 to 2 percent slopes
18	Keyner Variant loamy sand
19	Kim-Canyon complex, 2 to 10 percent slopes
20	Kim-Harvey loams, 1 to 3 percent slopes
21	Kim-Harvey-Stoneham loams, 1 to 3 percent slopes
22	Kim Stoneham Larimer loams, 3 to 12 percent slopes
23	Limon clay
24	Manzanola clay loam, 0 to 2 percent slopes
25	Midway clay, 5 to 12 percent slopes
26	Norka silt loam, 0 to 2 percent slopes
27	Olney loamy sand, 0 to 2 percent slopes
28	Otero sandy loam, 1 to 5 percent slopes
29	Playas
30	Richfield silt loam, 0 to 1 percent slopes
31	Shingle clay loam, 2 to 10 percent slopes
32	Singerton-Pultney complex, 1 to 10 percent slopes
33	Stoneham loam, 0 to 3 percent slopes
34	Stoneham-Kim loams, 0 to 2 percent slopes, eroded
35	Sundance loamy sand
36	Sundance-Fort Collins complex, 0 to 2 percent slopes
37	Valent loamy sand, 3 to 10 percent slopes
38	Valent-Blowout land complex, 2 to 8 percent slopes
39	Vona sandy loam, 1 to 3 percent slopes
40	Vona-Stoneham sandy loams, 1 to 10 percent slopes
41	Wiley loam

* Broadly defined map unit

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES
- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)
- Small airport, airfield, park, oilfield cemetery, or flood pool (Davis Airstrip; FLOOD POOL LINE)

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS
- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS
- Interstate (79)
- Federal (410)
- State (52)
- County, farm or ranch (378)

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES
- Without road
- With road
- With railroad

DAMS
- Large (to scale)
- Medium or small (water; w)

PITS
- Gravel pit (G.P.)
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES
- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) (Indian Mound)
- Located object (label) (Tower)
- Tank (label) (GAS)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE
- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) (CANAL)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS
- Perennial (water; w)
- Intermittent (int; i)

MISCELLANEOUS WATER FEATURES
- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS (SvE; 107)

ESCARPMENTS
- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

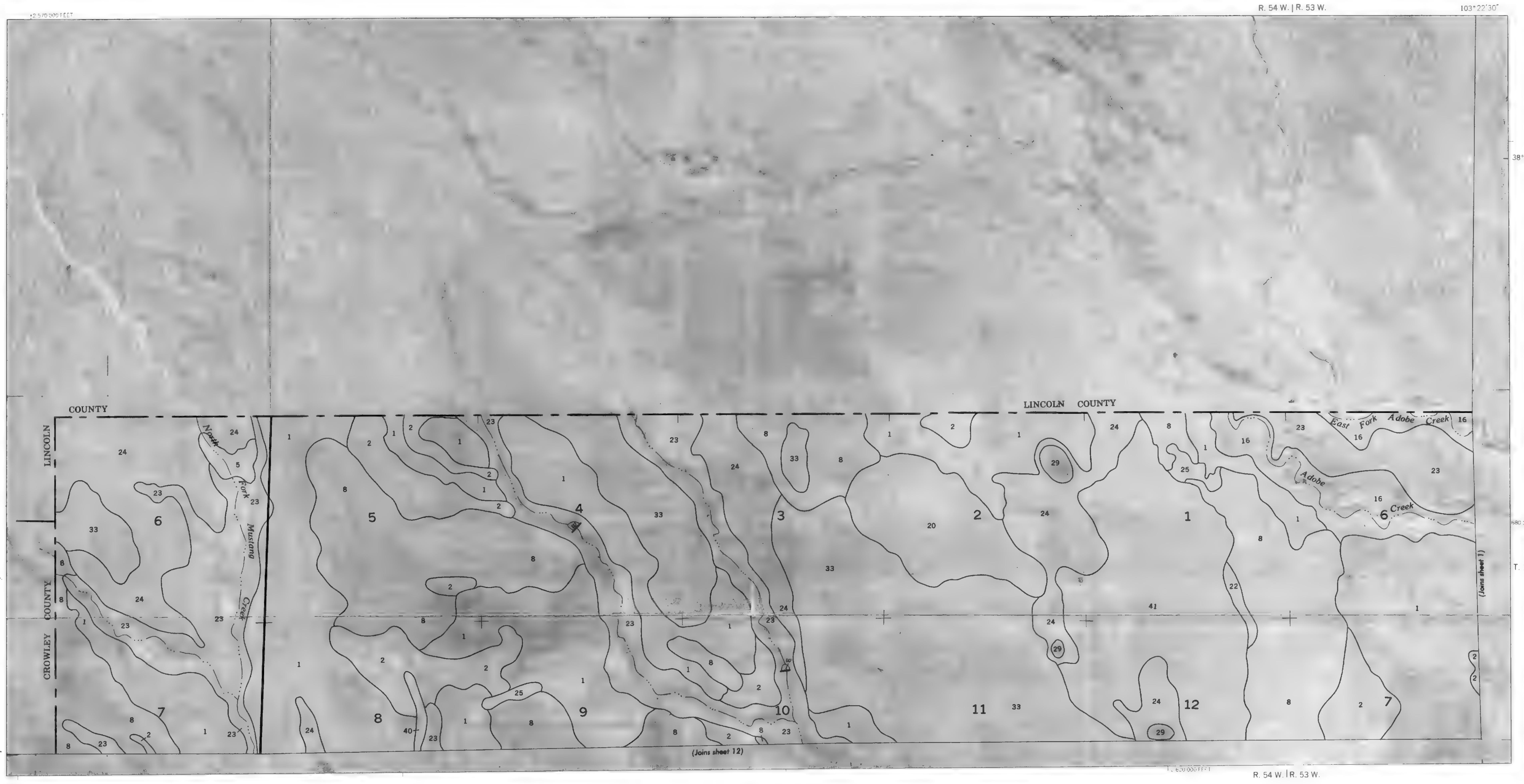
SOIL SAMPLE SITE (normally not shown) (S)

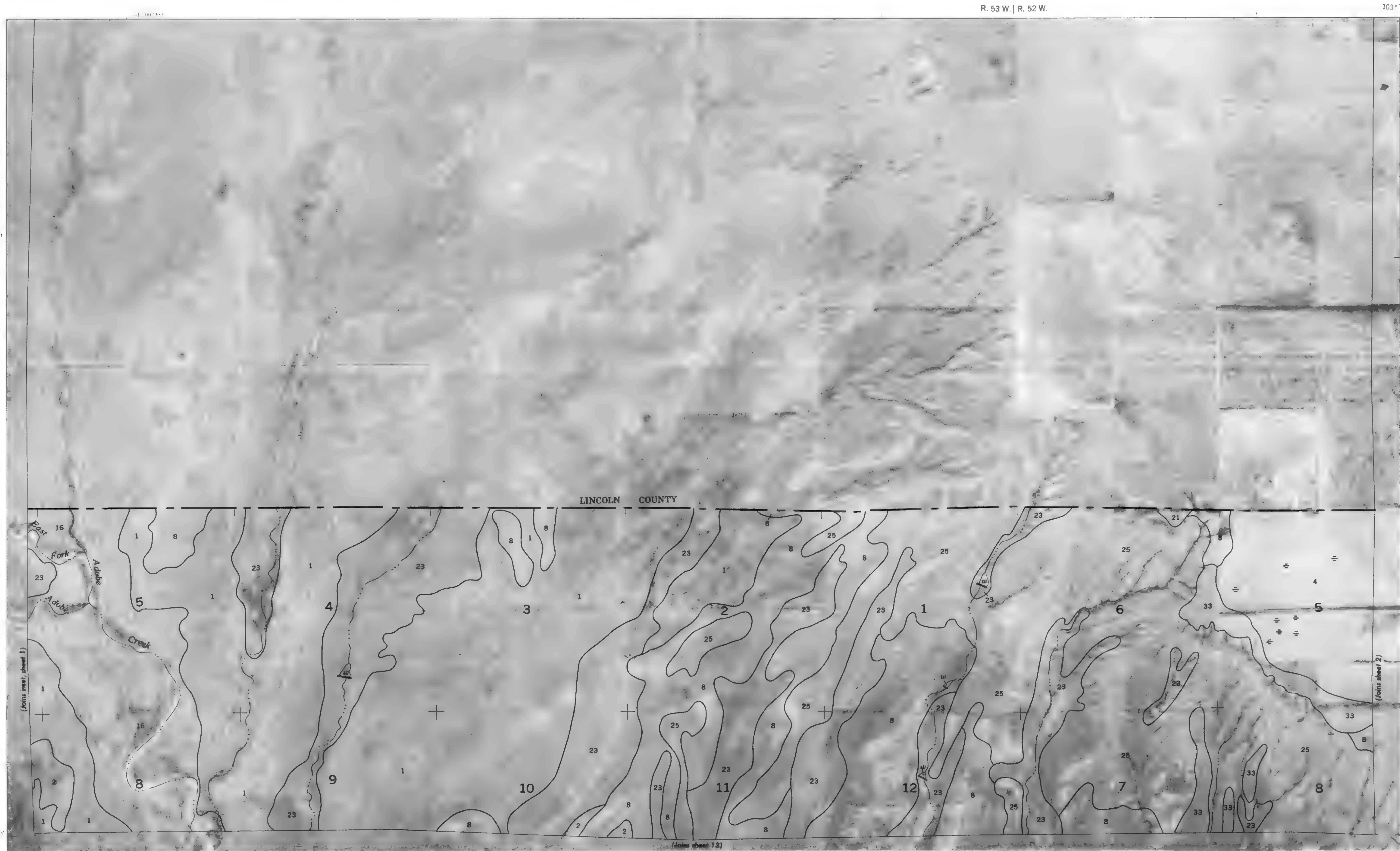
MISCELLANEOUS
- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 1
KIOWA COUNTY, COLORADO
(BLUFF SPRING QUADRANGLE)

INSET





This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 2
KIOWA COUNTY, COLORADO
(GALATEA SW QUADRANGLE)

This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies

1 ½ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned

Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

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SOIL CONSERVATION SERVICE

SHEET NO. 4
KIOWA COUNTY, COLORADO
(KIT CARSON 3 SW QUADRANGLE)

R. 50 W. | R. 49 W.

103°00'00"

Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

Scale 1:24 000

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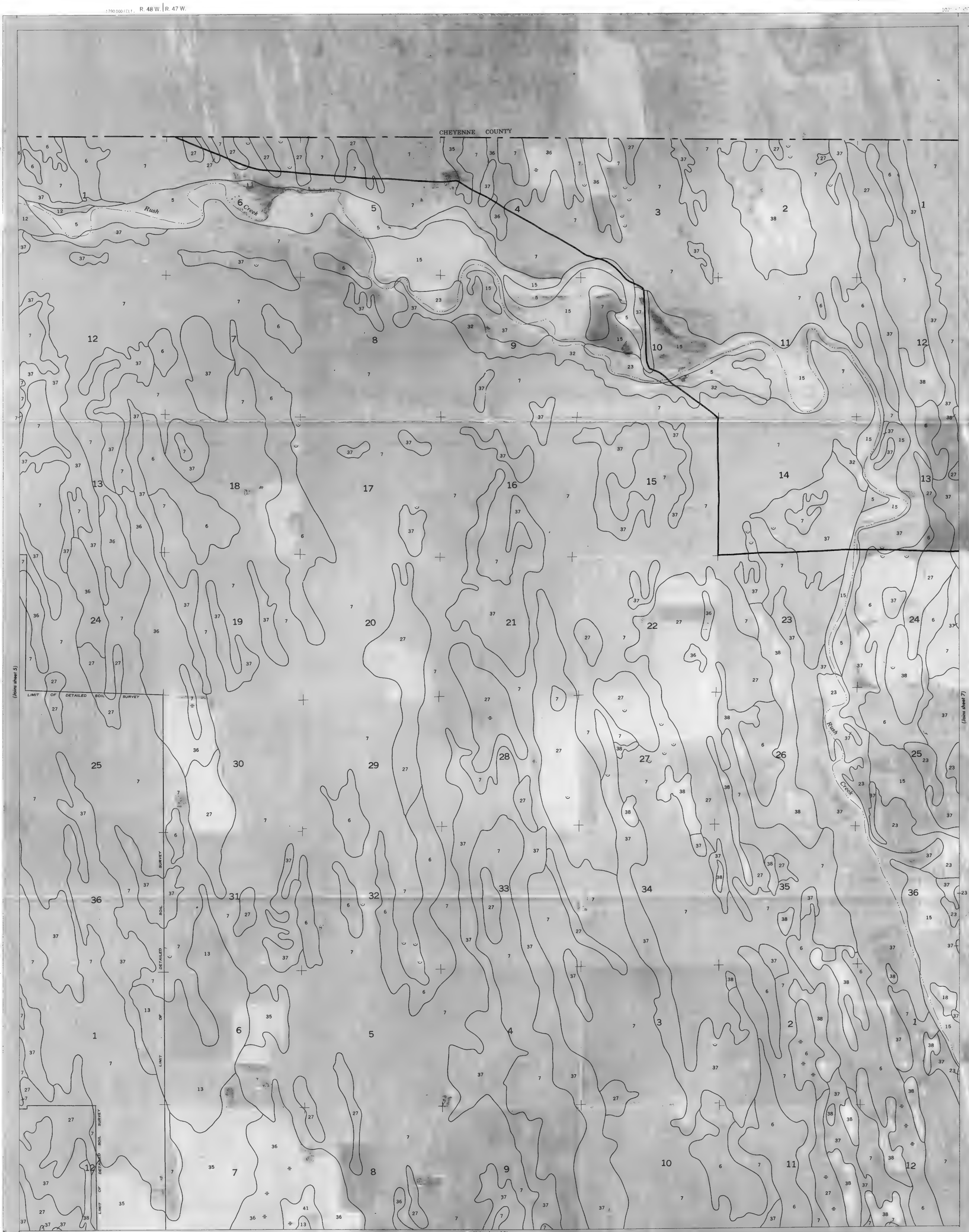
10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.



Scale 1:24 000

1 Mile · 0 · 2 Miles
5 000 Feet · 0 · 10 000 Feet

This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

R. 47 W. | R. 46 W.　　2 830 000 FEET　　R. 46 W. | R. 45 W.　　102°30'00"

38°30'00"　　R. 47 W. | R. 46 W.　　2 850 000 FEET　　R. 46 W. | R. 45 W.

102°37'30"

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

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Scale 1:24 000

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

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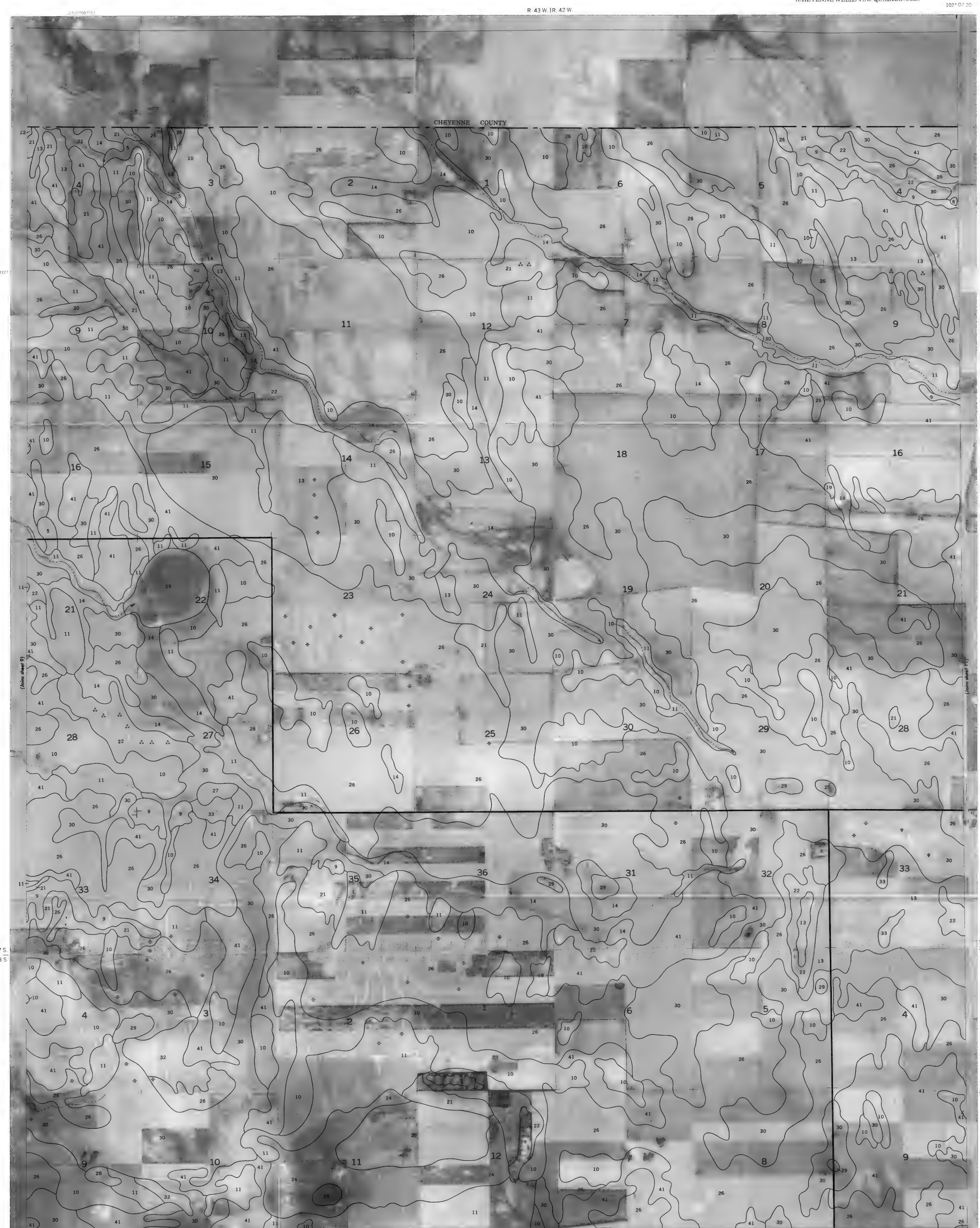
SHEET NO. 10
KIOWA COUNTY, COLORADO
(CHEYENNE WELLS 4 SW QUADRANGLE)



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Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

Scale 1:24 000

1 Miles 0 1 2 Miles

5 000 Feet 0 10 000 Feet

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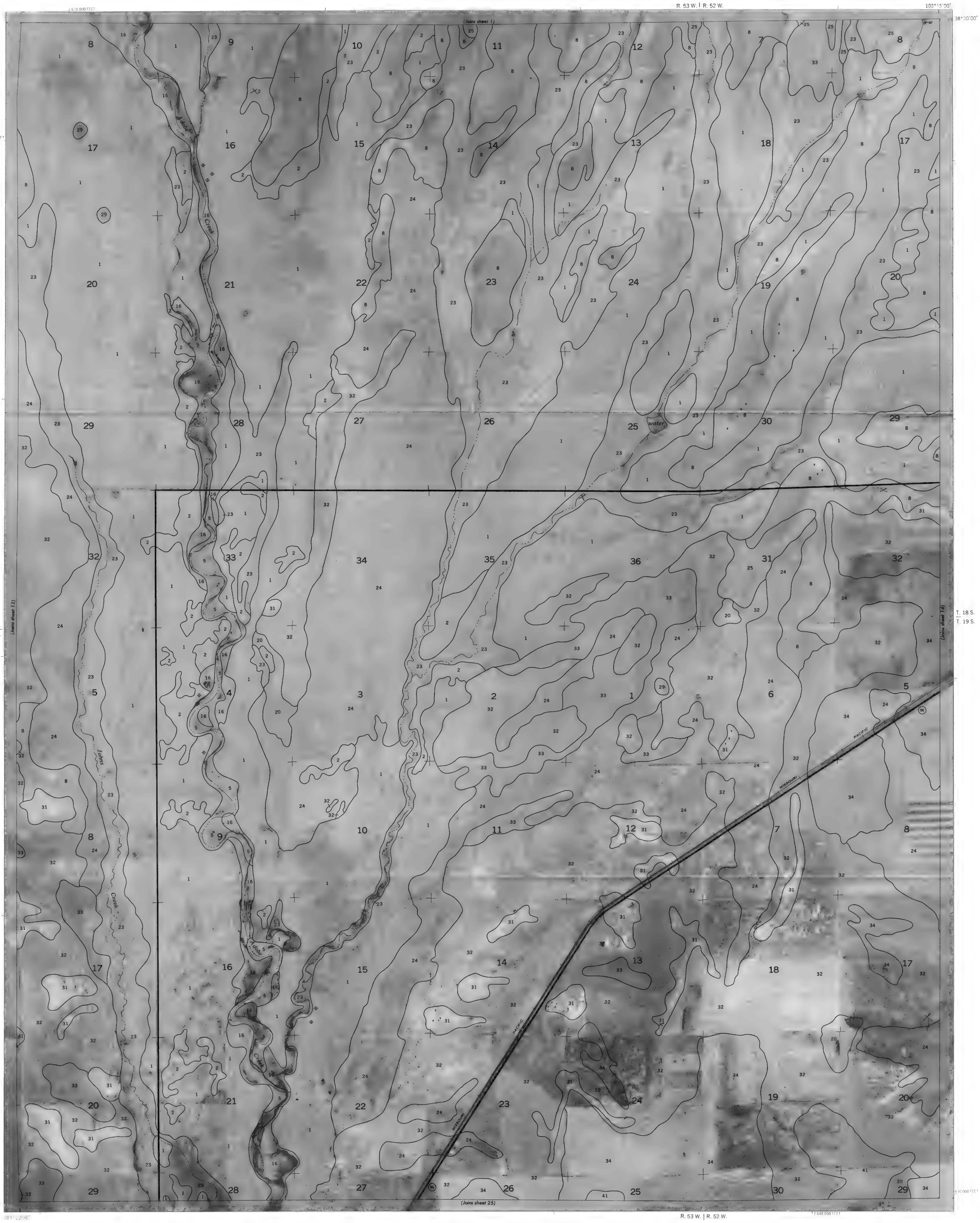
10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.



1 ½ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

Scale 1:24 000

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

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SOIL CONSERVATION SERVICE

SHEET NO. 15
KIOWA COUNTY, COLORADO
(HASWELL NE QUADRANGLE)

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

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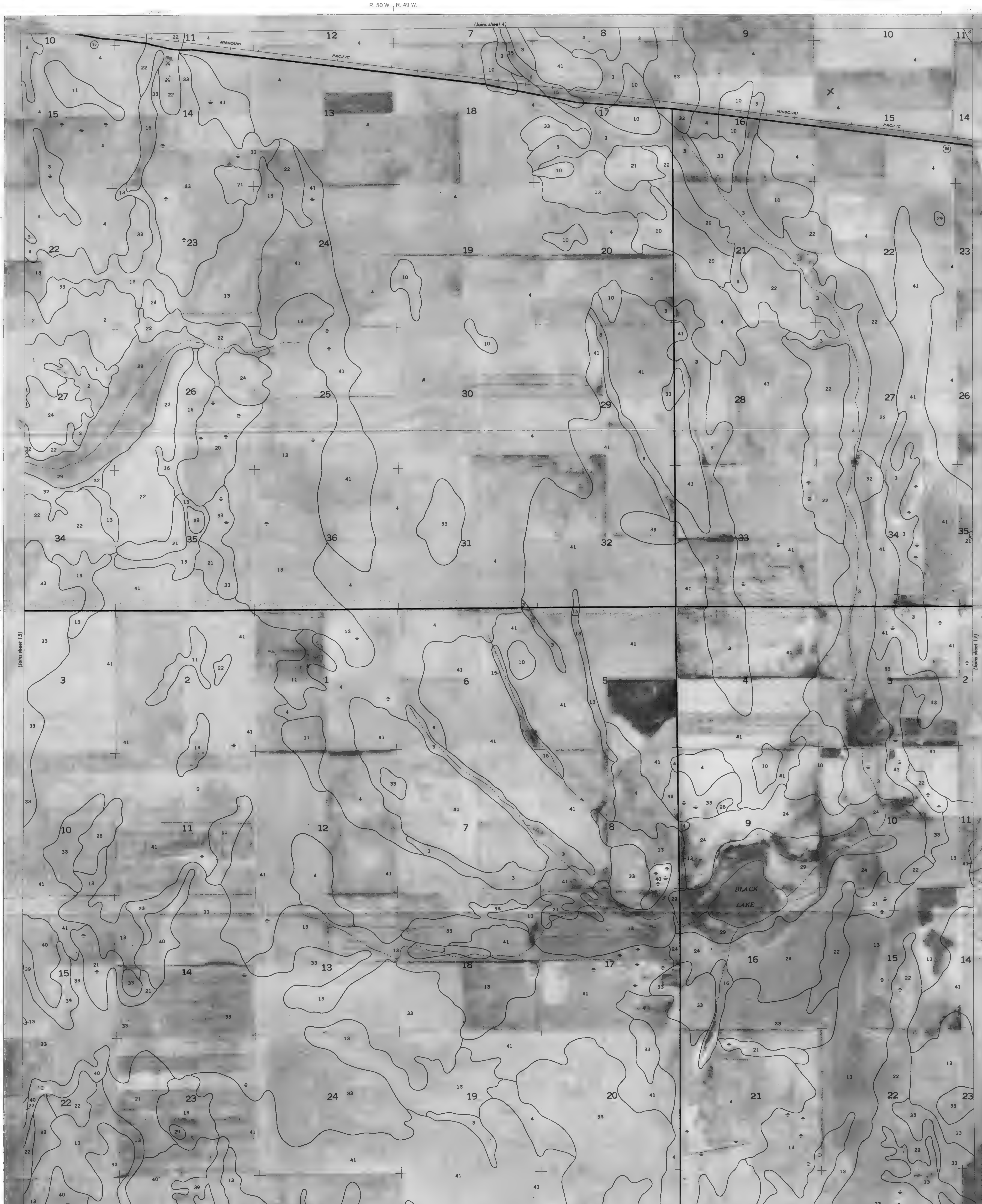

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

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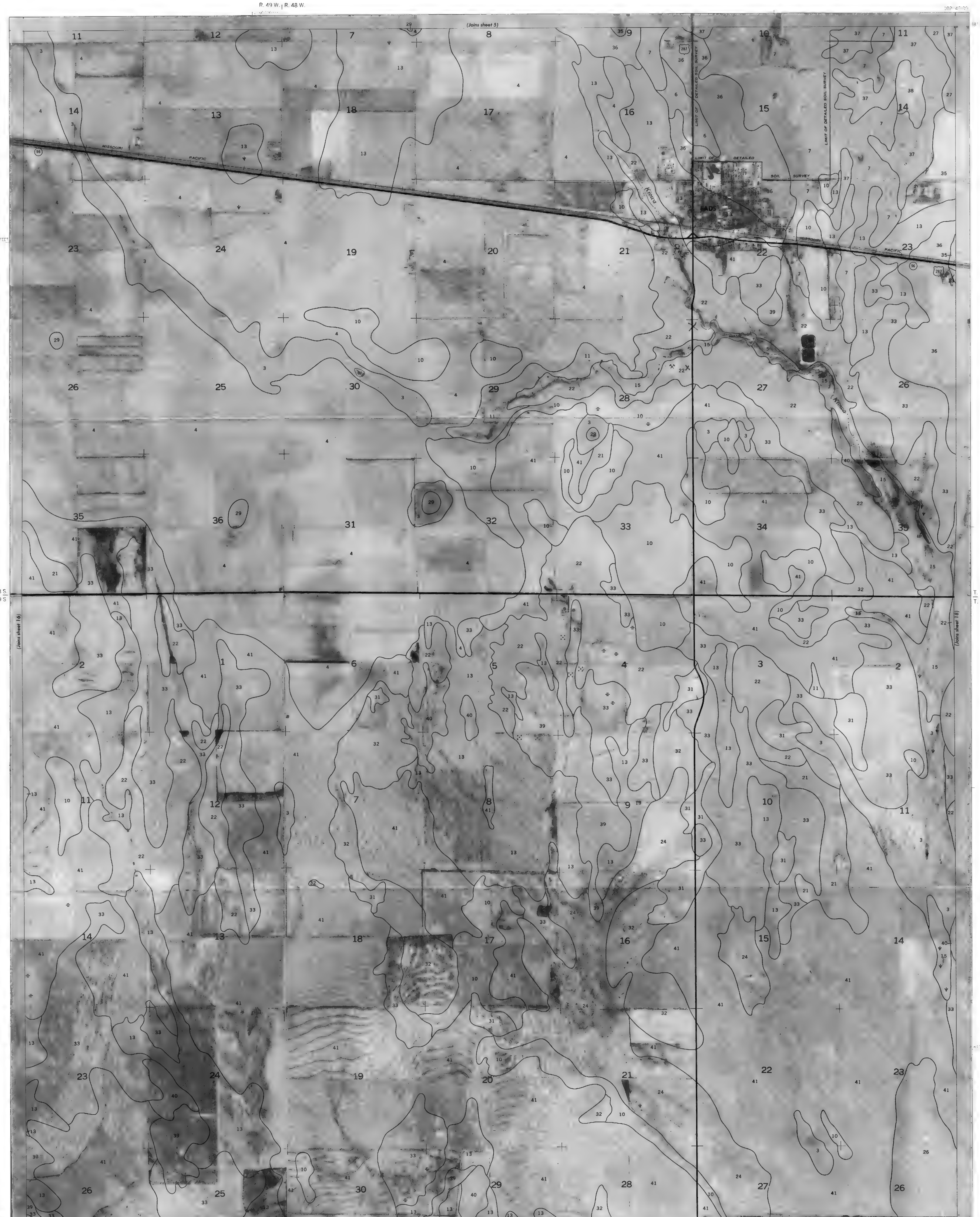
SHEET NO. 17
KIOWA COUNTY, COLORADO
(EADS QUADRANGLE)



2 Miles
5 000 Feet
10 000 Feet
Scale 1:24 000

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned

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SHEET NO. 18
KIOWA COUNTY, COLORADO
(ALKALI LAKE QUADRANGLE)

Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

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Scale 1:24 000

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SHEET NO. 20
KIOWA COUNTY, COLORADO
(BRANDON QUADRANGLE)

Scale 1:24 000
1 Mile, 0, 1, 2 Miles
5 000 Feet, 0, 5 000 Feet, 10 000 Feet

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SHEET NO. 21
KIOWA COUNTY, COLORADO
(SHERIDAN LAKE QUADRANGLE)

Scale 1:24 000

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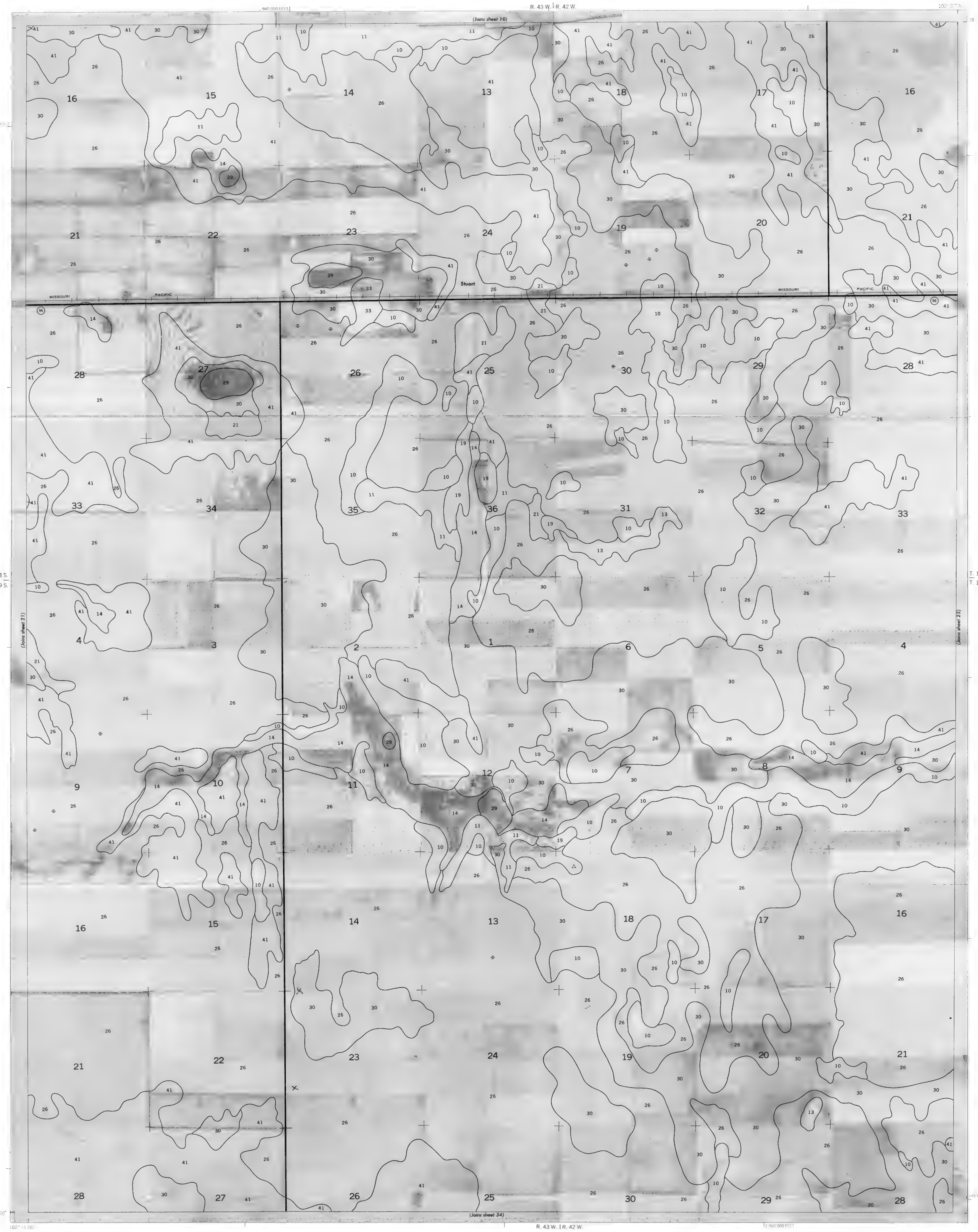
10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.



Scale 1:24 000

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

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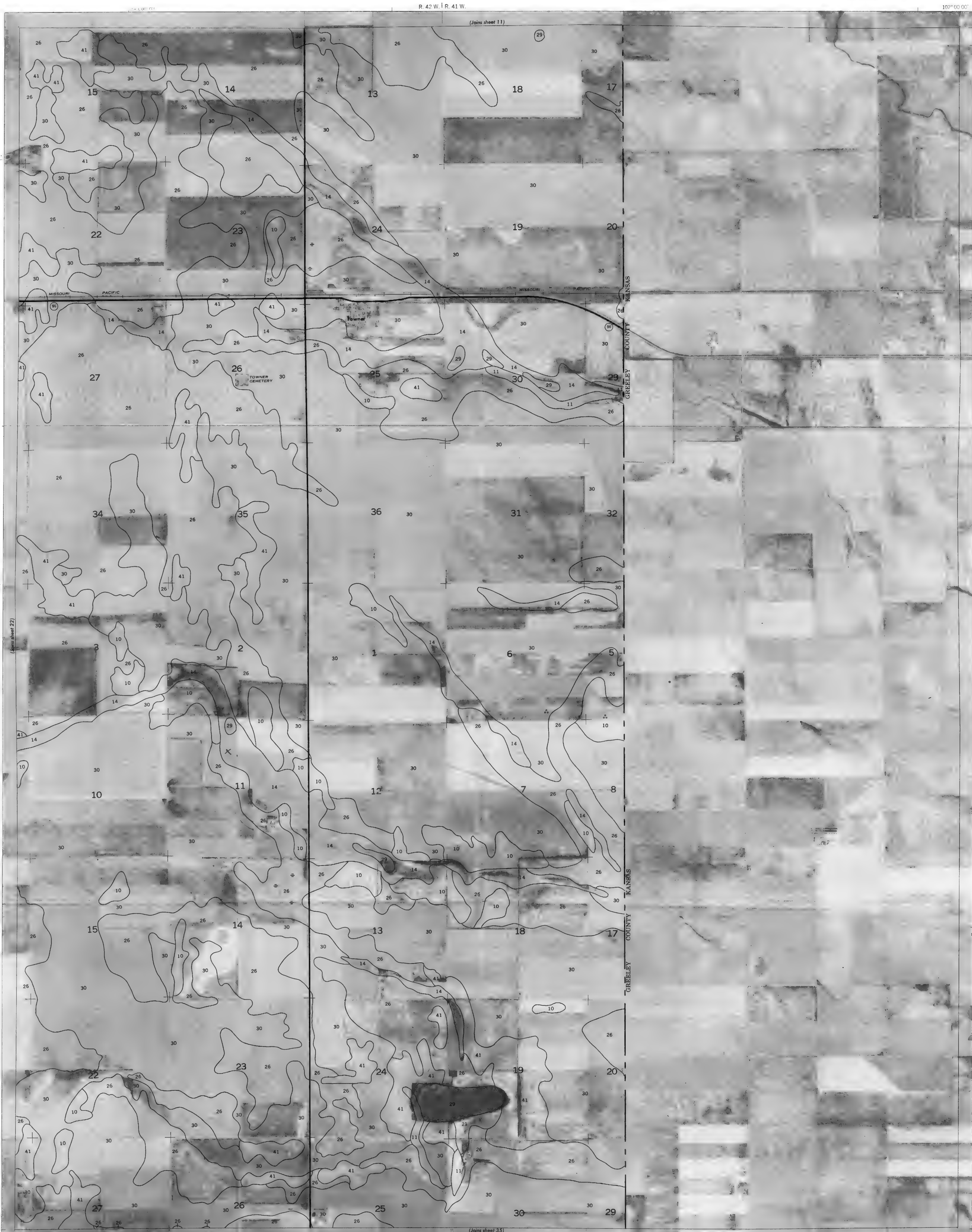
SHEET NO. 23
KIOWA COUNTY, COLORADO
(TOWNER QUADRANGLE)



1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned

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SHEET NO. 24
KIOWA COUNTY, COLORADO
(HOUSTON LAKES QUADRANGLE)

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Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Scale 1:24 000
1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

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SOIL CONSERVATION SERVICE

SHEET NO. 26
KIOWA COUNTY, COLORADO
(LONG LAKE QUADRANGLE)

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Scale 1:24 000

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned

Scale 1:24 000

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

1 ¾ ½ ¼ 0 1 2 Miles
5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet
Scale 1:24 000

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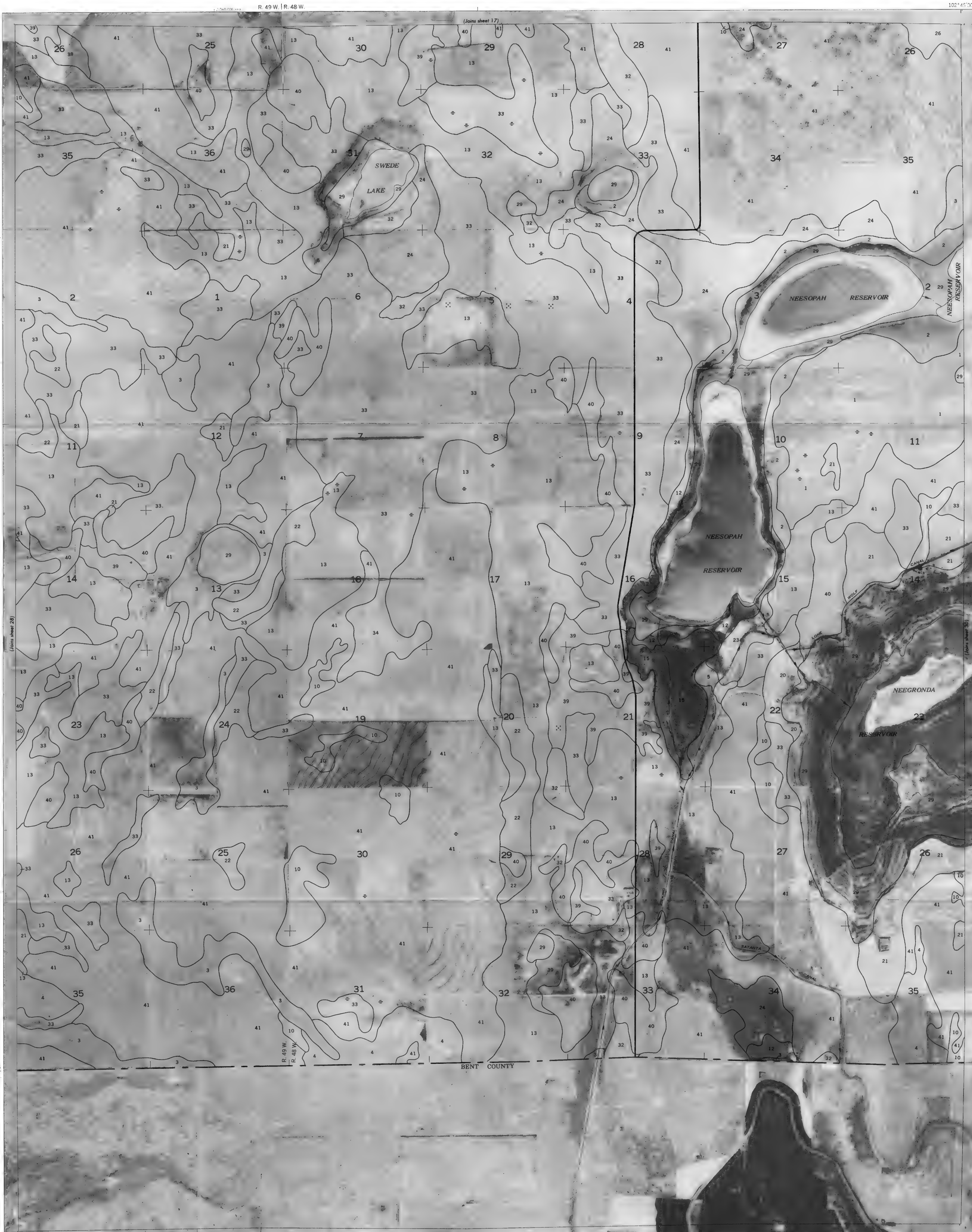
SHEET NO. 29
KIOWA COUNTY, COLORADO
(SWEDE LAKE QUADRANGLE)



This map is compiled on 1975 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies

Scale 1:24 000

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 30
KIOWA COUNTY, COLORADO
(NEENOSHE RESERVOIR QUADRANGLE)

Scale 1:24 000

2 Miles — 5 000 Feet — 10 000 Feet

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 31
KIOWA COUNTY, COLORADO
(CHIVINGTON SE QUADRANGLE)

This map is compiled on 1975 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.

Scale 1:24 000

10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

Scale 1:24 000

5 000 Feet — 10 000 Feet — 2 Miles

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

SHEET NO. 33
KIOWA COUNTY, COLORADO
(SHERIDAN LAKE SE QUADRANGLE)

Scale 1:24 000

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned

1 ¾ ½ ¼ 0 1 2 Miles

5 000 4 000 3 000 2 000 1 000 0 5 000 Feet 10 000 Feet

Scale 1:24 000

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.

Scale 1:24 000

1 Mile — 0 — 1 — 2 Miles

5 000 Feet — 0 — 5 000 Feet — 10 000 Feet

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10,000-foot grid ticks based on state coordinate system. Land division corners, if shown, are approximately positioned.